Environmental Impact Assessment at Fort Victoria Power Station

Prepared for **Central Electricity Board, Mauritius**

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1

Introduction

1.1 Background

The power station is situated at Fort Victoria, in Cassis ward, Port Louis. The power station has two separate engine houses. The first engine house has seven Mirrlees engines installed between 1974 and 1978. Each Mirrlees engine (U.K.) is of capacity 5 MW, type 16 KV MAJOR. The second engine house has two 10 MW MAN engines (Germany), type 8L 58/64 (installed in 1988-89). All the engines run on 180 Cst Heavy Fuel Oil. Energy production from Fort Victoria Power Station was 99.3 Gwh for the year 2000. The two MAN engines operating on semi-base load have generated 64 Gwh. The power generation from Mirrlees engines was 35 Gwh, inspite of a substantial decrease of operating time per generating set.

The Fort Victoria Power Station has been experiencing problems with respect to air, noise and vibration pollution caused by the power station. The residents in the neighbourhood have been complaining to the Ministry of Environment, Government of Mauritius over the last few years. As a response to these complaints, the Ministry of Environment had issued an order directing the power station authorities to operate the plant only between 7 am and 9 pm (Annexure 1.1). In addition, they have also directed the authorities to carry out an environmental impact assessment of the Fort Victoria Power Station.

1.2 Objectives

The objective of the study is to carry out an environmental assessment of the air, noise and vibration pollution caused by the power station and their impacts on the nearby inhabitants as well as recommend abatement measures as may be appropriate. The study area would cover an impact zone of about one km, surrounding the power station. The specific objectives are to undertake an assessment of the pollution level around the station in respect of:

- Particulate matter
- Gas emissions e.g. CO, CO_2, NO_2, and SO_2
- To assess the meteorological effects and assess dispersive properties of the installation and actual incidence on ambient air quality in the immediate vicinity of the power station.

- To assess the actual level of noise and vibration pollution caused by the power station to the environment and the community in the area.
- To assess the health and social impact of the environmental pollution caused by the power station to residents of the neighbouring areas.
- To recommend mitigating measures to abate air, noise and vibration pollutions caused by the operation of the power station. The steps proposed to limit these negative effects on the environment will be described and their cost estimated.

All the above assessment shall be compared with the current environmental regulations applying in Mauritius or, if these are lacking, to international regulations.

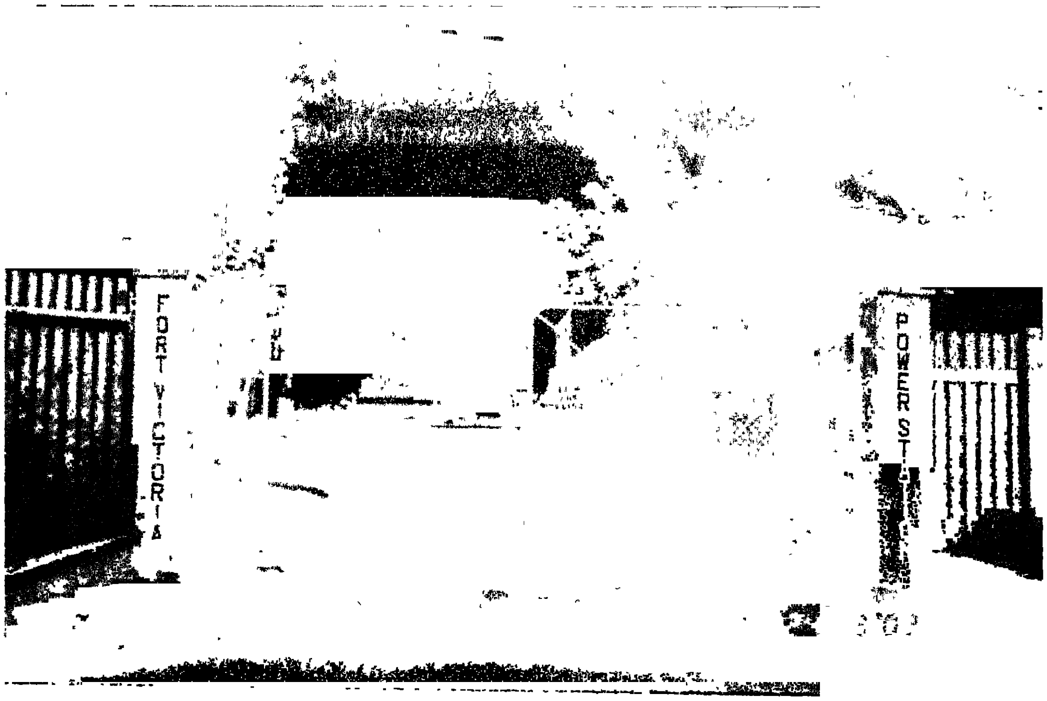


Figure 1.1 Fort Victoria power station at Cassis, Port Louis

1.3 Work plan and methodology

The project team from TERI undertook a site visit for discussion with the power plant officials, and collection and assessment of the baseline environmental quality status. The TERI team comprising of Mr P V Sridharan, Dr T S Panwar, Mr Jacob George and Mr R Suresh reached Mauritius on the 10th of March, 2002. Dr A L Aggarwal, who was already in Mauritius, joined the team on the same day. Dr Y P Abbi joined the team later on the 17th of March.

The first meeting with the CEB officials was held on the 11th March, 2002 at the Fort Victoria Power station. Mr G Hebrard, Production Manager, Mr S K Thannoo, Mechanical Engineer, and Mr Raynald Carcasse, Chief Technician, participated in the meeting. The plant officials informed the TERI team about the environmental problems being faced by the plant including the complaints by the residents in the neighbourhood.

The TERI team requested for detailed information including environmental reports/ site maps and local land use maps/ meteorological data/ census data/ engine details/ fuel characteristics/ stack details/emission levels/ government standards and guidelines/written complaints or notices served on the plant/ etc.

A visit to the engine houses was organised. Subsequently, the visit to the neighbourhood was also organised. Individual meetings were held with the plant officials to get further details and other relevant data. Based on the onsite inspection and the nature of complaints received, along with study of the available data, the field monitoring sites were finalised and a monitoring schedule was prepared. For the study area, an impact zone of approximately one km was taken which extended up to the highway in the South-East direction and the background station in the East direction.

The plant officials provided us the necessary logistical support during the monitoring period that facilitated our work, and we are extremely thankful to them for the same. A room was provided in the power station that was converted into an environmental laboratory. Thus, a field station was set up that was complete with all the necessary scientific instruments as well as a fully functional environmental laboratory.

A meeting was arranged on the 15th March by the CEB with Ministry of Environment officials to update them regarding the study being undertaken and seek their suggestions on the same. Regular meetings were held with the plant officials to discuss about the progress of the work and modify the work plan, whenever necessary, based on mutual discussions.

Based on the wind rose information collected from Meteorological service, Government of Mauritius, layout of nearby residential areas, information regarding complaints from neighbourhood, and representativeness of the stations, a total of 6 locations were selected for ambient air quality monitoring. The air monitoring equipments were transferred to their respective locations in and around the plant, including the residential areas. Likewise, after survey of the study area and based on discussions with the power station officials, 11 stations were selected for noise level monitoring. The noise measurements were taken with the help of a noise meter that was easily portable. Local staff was hired to assist us in the field monitoring. The staff was duly trained and then under the supervision of the TERI staff, measurements related to air quality and noise were taken. The stack emissions were also measured by the TERI team and onsite meteorological data was recorded.

A site visit was organised to meet the residents in the neighbourhood of the plant on the 21st March, 2002. Mr S K Thannoo accompanied the consultants for this visit to the complainants houses. The complaints related to noise, vibration as well as smoke. The residents showed the cracks in the walls and the falling plaster from roof. Meetings were held with the following persons and the details are as follows:

1. Mr Purussram Greedharee: His house is just adjacent to the plant boundary near the MAN engine. The main complaint was that there is lot of vibration and noise and they are unable to open the door/windows facing the station. He also showed cracks in the house at several places. Smoke from the engines (in particular from Mirrlees) is also a problem, especially when the wind direction is towards their residence. He has taken up the matter with the government authorities and gave copies of the press coverage about the problem being faced by them.
2. Mr Devadasn Subramanien Mudaly: His house is about 20-25 m away from the plant boundary. He showed cracks in the walls on the upper floor of the house and complained of noise, vibration as well as smoke. His said that his mother has developed hearing problem as well as respiratory problem.
3. Mr Sinasamy Vadeevaloo: His house is about 100 m away from the plant and they have been staying here since the past 40 years. They have a severe problem of falling of the plaster. Smoke is also a cause for concern and health problems in terms of throat infections were reported both in adults and children.
4. Mr Perounamaden Vadeevaloo: They have problems related to cracks developing in the ceiling and the vibration of the doors was severest. This may be due to the fact that this house is by the side of the MAN engine, just about 20-25 m from the fence.
5. Ms Devyanee Poonye: She has been staying here for the past 34 years. She complained about the problem of cracks in the ceiling, vibration of doors, as well as smoke. Health problem was in terms of hearing impairment.

2

Assessment of baseline environmental quality

Based on the site assessment by the TERI team and the discussions held with the Fort Victoria Power Station officials, the environmental monitoring plan was finalised. Monitoring activities were undertaken for the following aspects in accordance with the TOR of the study:

1. Onsite Meteorological data collection
2. Air Quality monitoring
3. Stack emissions monitoring
4. Noise monitoring

The monitoring activities commenced on the 20th of March 2002 and continued round the clock for a period of 6 days till the 26th of March 2002.

2.1 Analysis of engines performance data (1998-2001)

The performance data for the MAN and Mirrlees engines for the last four years (1998 to 2001), were collected and analysed for average operating load, mass fuel consumption per kWh power generated, thermal efficiency, scheduled and unscheduled outages against total hours run since commissioning. The latter is considered as the base as this represents the wear out of the engine parts which affects its performance. Year-wise performance data for the engines are given in Annexure 2.1.

2.1.1 Analysis of performance of MAN engine (No. 11)

The performance data for the MAN engine is summarised in Table 2.1 and the same is plotted in Figures 2.2 & 2.3. The specific fuel data for this engine as per design is taken from Annexure 2.2. This is the test data collected at site by the manufacturer after the installation and commissioning of the engine.

It may be seen from Table 2.1 that the engine is run at an average load of around 75%. The best efficiency of these engines is at 85 to 100% load. Thus, it is recommended that the engines should be run at higher loads and the Mirrlees engines should be backed down if the load demand is less.

Table 2.1 Analysis of past performance data for the MAN Engine (No. 11)

Rated capacity of the engine = 10,202 kW

S. No.	Description	Year			
		1998	1999	2000	2001
1	Total hours run since commissioning (h)	51806	58211	63020	67531
2	Running hours during the year, (h) for 2 engines	10238	12663	8071	8102
3	Standby hours during the year (h) for 2 engines	3038	2798	3033	6736
4	Power generated during the year (kWh) by 2 engines	80168900	99739400	64354100	62665100
5	Average load at which the engine is run (%)	76.75	77.20	78.16	75.81
6	Mass fuel (g/kWh generated)	200	200.29	202.85	207.33
7	Thermal efficiency (%)	44.10	44.06	43.49	42.54
8	Scheduled maintenance per year (h)	1719	690	2617	1075
9	Unscheduled outage per year (h)	403	340	616	267

Note. Except for S.No. 1, all data is the average data.

Assumption: No fuel consumption during standby hours.

Box 2.1 Performance data (MAN Engines) as given by manufacturers

Test Data at site (after installation)

Specific fuel consumption (g/kWh) for engine (based on 42707 kJ/kg fuel)	177.1
(based on 42567 kJ/kg fuel being used presently)	= 177.68
Generator efficiency	= 96%
Thus specific fuel consumption (g/kWh generated)	= 177.68/0.96 = 185.08

The specific fuel consumption is also high as compared to the design value, which is for loads of 85% and above. In addition, these engines are not run continuously as base load; but on semi-base load. During the start of the engine and actual synchronisation, there is always a time gap and the engines are in idling mode. In this mode of operation the fuel consumption is theoretically about 25% of the full load, but no power is generated. Thus, overall fuel consumption is high; average is about 202 gm/kWh as compared to design value of 185.08 gm/kWh which is a deviation of 8% only. This situation cannot be improved much when the engines are used for semi-base load conditions.

The unscheduled maintenance, which is a direct indicator of frequency of breakdowns, is reasonable for all the years. However, the scheduled maintenance hours appear high in the years 1998, 2000 and 2001. The power station authorities informed that the maintenance hours reported above should be divided by 24 to get the number of days of maintenance. Also the scheduled maintenance for these engines is around 75 days in a year.

In view of the above, the scheduled maintenance days in 1998, 2000, and 2001 are 72, 109, and 45. The high figure for the maintenance in the year 2000 in fact refers to the major overhauling carried out after 60,000 hours of operation when all the liners were changed as recommended by the engine manufacturer.

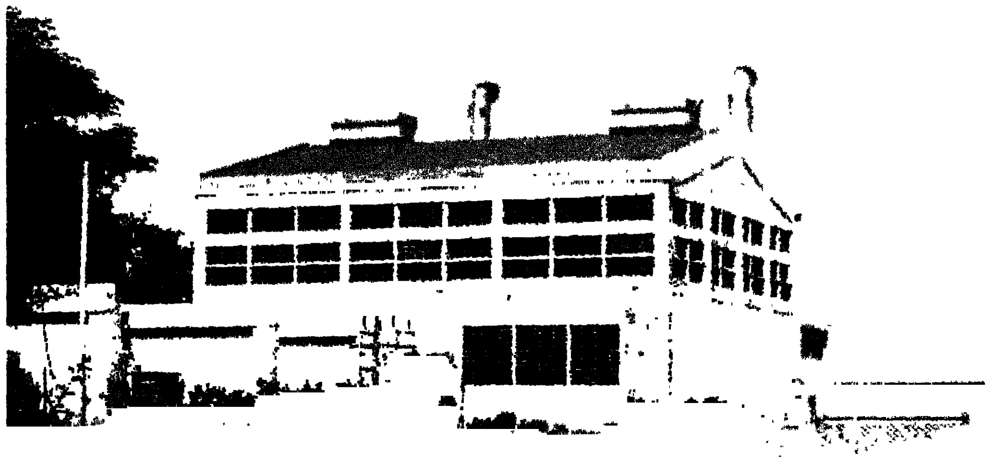


Figure 2.1 MAN engine house at Fort Victoria Power Station

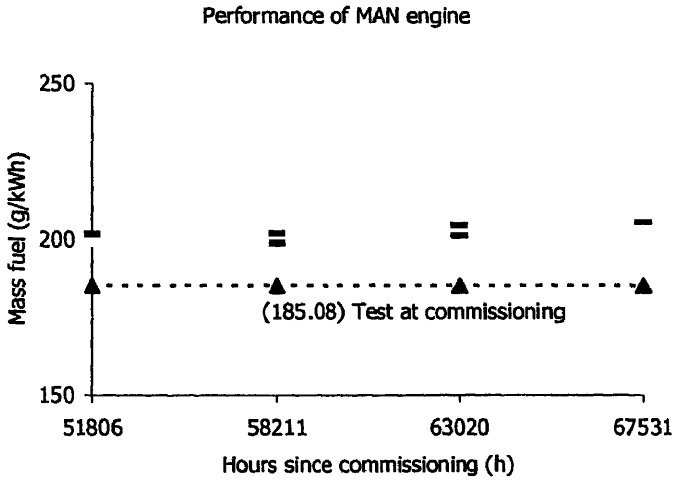


Figure 2.2 Performance of MAN engine

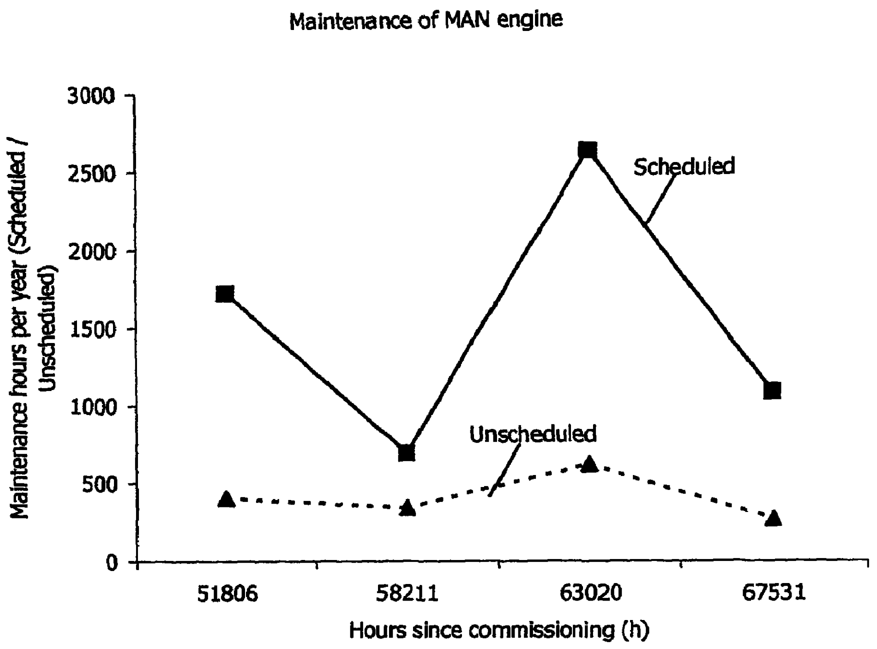


Figure 2.3 Maintenance of MAN engine

2.1.2 *Analysis of performance of Mirrlees engine (No. 9)*

The performance data for the Mirrlees engine (No. 9) is compiled in Table 2.2 and the same is plotted in Figures 2.4 and 2.5. The specific data for this engine as per design is taken from the test-bed data (Annexure 2.3) provided by suppliers of the engine.

Table 2.2 Analysis of past performance data for the Mirrlees Engine (No. 9)

Rated capacity of the engine = 6600 kW

S. No.	Description	Year			
		1998	1999	2000	2001
1	Total hours run since commissioning (h)	57860	61188	63441	64134
2	Running hours during the year, (h) 7 - engines	21371	20314	10852	5613
3	Standby hours during the year (b) 7 - engines	45217	40511	46307	61003
4	Power generated during the year (kWh) 7 - engines	74786080	70297310	34923720	17818520
5	Average load at which the engine is run (%)	53.02	52.43	48.76	48.10
6	Mass fuel (g/kWh generated)	250.49	256.57	268.28	273.81
7	Thermal efficiency (%)	35.18	34.35	32.83	32.11
8	Scheduled maintenance per year (h)	466	870	1017	4166
9	Unscheduled outage per year (h)	759	931	1173	1947

Box 2.2 Performance data (Mirrlees Engine) as given by manufacturers

Test bed data (after manufacturing)

Generator efficiency = (6600 / 6872) x 100 = 96.04%

Specific fuel consumption (g/kWh) for different loads is as follows:

Load	**Load**	**Load**
100%	75%	50%
205/0.9604	205/0.9604	210/0.9604
= 213.45	= 213.45	= 218.66
Corrected for 42567 kJ/kg fuel being used currently		
= 214.15	= 214.15	= 219.38

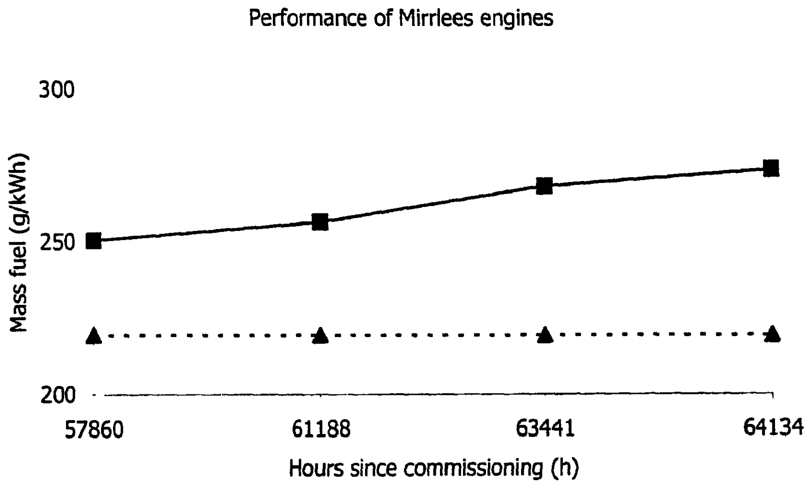


Figure 2.4 Performance of Mirrlees engines

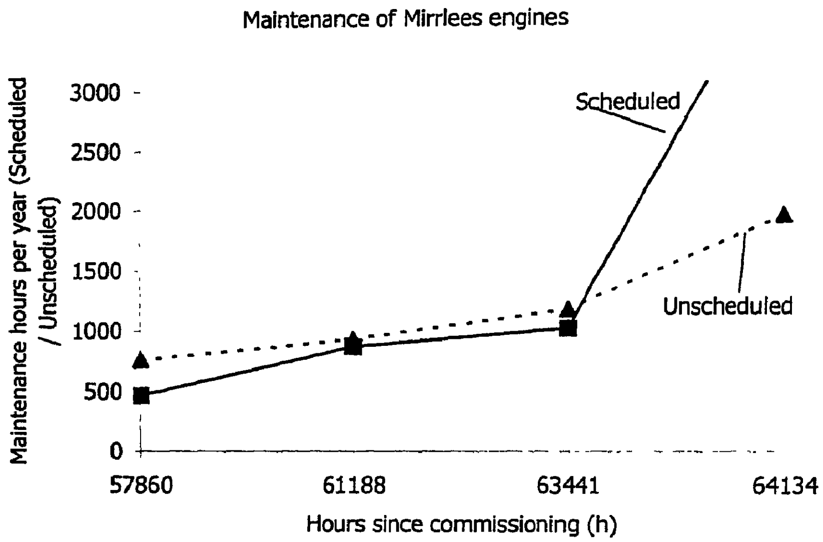


Figure 2.5 Maintenance of Mirrlees engines

It may be seen that the engine is run at an average load of around 50%. The best fuel efficiency of such engines is obtained at loads of 85% and above. The specific fuel consumption data also indicates that at 50% load, the consumption is 210 g/b kWh as compared to 205 g/b kWh between 75 to 100% load i.e. about 2.5% higher. Thus, it is recommended that engines should be run for the maximum amount of time between 75% to 100% loads. This means than instead of running two engines at 50% load, one engine should be run at 100% load. This practice will improve specific fuel consumption by at least 2.5%.

Further reduction in specific fuel consumption is possible by reducing the time of idle running of the engines. This is possible by knowing the precise timings when these engines are required to run to meet the peak load power demand of the grid. The engines should be started few minutes before the actual requirement. This practice of operation plus running the engines between 75 to 100% loads for the maximum possible periods, will bring the specific fuel consumption very close to the design value.

The scheduled and unscheduled maintenance hours are also high for these engines. For improving this, the maintenance planning and execution has to be improved as suggested in Section 2.1.1. For reducing the unscheduled outages, the reasons for the outages should be analysed, and the components/sub-system having frequent break-downs should be modified or replaced.

CEB's views on the performance of these engines are as follows:

"These engines are presently running for peaking operations, which have a considerable impact on the specific fuel consumption. We would like to inform you that before starting any engine and synchronizing same on the grid, the dispatching center informs the station well in advance so that the operator has sufficient time to start the auxiliaries, etc.

Maintenance planning is carried out as per engines' manufacturer schedule. We would also like to point out that there is presently a policy of phasing out the Mirrlees engines and analysis of mode of operation should be viewed in conjunction with the present mode of operation of these engines as well as the constraints imposed upon us by the Ministry of Environment. These engines have not been designed to operate in the present configuration and outages beyond control are bound to occur and performance is bound to suffer as well".

2.2 Stack emissions and comparison with design values and emission standards

One representative engine each was chosen for monitoring the emissions from the MAN and Mirrlees engines. Port holes were requested to be opened so that the samples could be taken. The MAN engine number 11 (single stack) and Mirrlees engine number 9 (two stacks: left and right) were selected for the emissions monitoring. The stacks from the Mirrlees engines are not insulated resulting in very high temperatures outside the stack, and thus it was under very difficult circumstances that the samples were collected.

Three samples were taken from each of the representative stacks leading to a total of 9 samples. The stack measurements were carried out on the days when air quality monitoring was being done. The parameters monitored and the instruments used are as follows:

- Flue gas temperature – Stack sampler (APM 615 Envirotech make)
- Flue gas velocity – Stack velocity monitor
- Particulate matter - Stack sampler (APM 615 Envirotech make), collection in thimbles
- CO - Flue gas analyser (Spectra 1600-GL, MRU GmbH make)
- CO_2 - Flue gas analyser (Spectra 1600-GL, MRU GmbH make)
- O_2 - Flue gas analyser (Spectra 1600-GL, MRU GmbH make)
- NO_2 - Stack sampler (APM 615 Envirotech make), chemical method
- SO_2 - Stack sampler (APM 615 Envirotech make), chemical method

Information relating to the operational details of the engines were also collected on daily basis (engines operating, hours of operation, total power generated) from the daily log sheets. The stack emissions details of various pollutants are given in Table 2.3.

Table 2.3 Observed data for stack emissions from Mirrlees & MAN engines

Location	Date (d.m.y)	Time (hrs.)	Engine Output (MW)	Flue gas temp. (°C)	SPM (mg/Nm³)	SO_2 (mg/Nm³)	NO_2 (mg/Nm³)	CO_2 (Vol%)	O_2 (Vol%)	CO (ppm)
MAN Engine 11										
1)	23.03.02	1035	9.0	350	105	1482	1134	5.5	13.2	45
2)	24.03.02	1000	8.5	353	157	853	1055	5.4	13.3	54
3)	25.03.02	0935	8.7	352	155	1318	1084	5 4	13.3	55
Average			8.7	352	139	1218	1091	5.4	13.3	51
Mirrlees Engine 9										
Left 1)	23.03.02	1700	4.0	384	103	1091	1209	6.3	12 2	465
Left 2)	24.03.02	1600	4.3	379	133	984	1267	6.3	12 5	390
Left 3)	25.03.02	1700	4.0	384	156	1094	1216	6.3	12.4	424
Right 1)	24.03.02	1645	4.3	385	157	935	1191	5.9	11.8	467
Right 2)	25.03 02	1735	4.0	386	152	775	1105	5.4	11.8	452
Right 3)	25.03.02	1810	4.0	384	165	1066	1204	5.5	11 9	455
Average			4.1	384	144	991	1199	6.0	12 1	442

2.2.1 Comparison with design data

The engine manufacturers were approached for supplying the test-bed data on exhaust emissions. Response was received only from Mirrlees Blackstone and a comparison has been made with actual emission data. This however was not possible for MAN engines.

The performance data and the emissions data for the Mirrlees engine (No. 9), as per design, at the operating conditions during testing has been given in Tables 2.4 and 2.5. This is based on the test bed data provided by the supplier as given at Annexure 2.3. The characteristics of the fuel used is given at Annexure 2.4.

Table 2.4 Performance Data (as per design) for Mirrlees engine

	Design (at 100% load)	Design at Av. operating load
Rated Capacity (kw)	6600	4000-4200 (Avg. 4100; Load 62.1%)
Generator efficiency (%)	96.04	96.04
Power output of engine (site) (bkwh)	6872	4269
Net calorific value of fuel (MJ/kg)	42.7	40.54
Specific fuel consumption (g/bkwh)	205.0	207.6

Table 2.5 Comparison of design and actual emission from Mirrlees Engine 9 at operating conditions

Parameter	Design Emission (Av. At operating load)**	Observed Emission (Avg. at operating load*)	Remarks
SPM (mg/Nm^3)	90	144	
SO_2 (mg/Nm^3)	2189	991	The design is for 3.5% Soil; actual operation with 2.36% S Oil
NO_2 (mg/Nm^3)	2348	1199	
CO_2 (% vol)	5.8	5.95	
02 (% vol)	14.3	12.1	
CO (ppm)	45.1	442	
Flue gas temp (oc)	375	384	

Note. ** Engine performance constant at 100% & 75% loads. Linear relationship assumed for loads between 75% and 50% loads. *** Design data is for fuel oil with Net CV=42.7 MJ/kg compared to fuel used in operation with Net CV=40.54 MJ/kg.

A comparison of the design and actual emissions from the Mirrlees engine 9 has been made in Table 2.5. It can be seen that:

i) SPM emission is higher than design value

ii) SO_2 emission is lower than design value

iii) NO_2 emission is lower than design value

iv) O_2 is lower than the design value

v) CO emission is very high

Low value of O_2 in the exhaust and high values of SPM (unburnt carbon) and CO clearly indicate that there is inadequate amount of air supplied, which leads to incomplete combustion of fuel in the engine. Hence, there is need to tune the engine for air to fuel ratio. This can be done easily by monitoring excess O_2 in the flue gas and adjusting it at a level of 14 to 14.5%. This will improve the combustion temperature in the engine cylinders and may lead to increase in NO_2. However, this is expected to remain within the design limits. The SO_2

emission is lower as the design is for 3.5% S oil whereas in actual operation, oil with 2.36% Sulphur is used.

2.2.2 *Stack emissions: comparison with emission standards*

Table 2.6 shows a comparison of the engine emissions data against the prescribed standards by the Government of Mauritius (Annexure 2.5). It is assumed here that m^3 refers to Nm^3). It may be noted that for SO_2, the standard applicable to power plants does not exist and thus a comparison is made against the World Bank guidelines. For existing plants, it states that SO_2 emission levels should meet regional load levels, while for new plants, the concentration of SO_2 in flue gases should not exceed 2,000 mg/Nm^3 and the same is taken for reference here. The emission guidelines for nitrogen oxides for engine-driven power plants states that if the resultant maximum ambient levels of nitrogen dioxide are less that 150 µg/m^3 (24- hour average), then for funding applications received after July 1, 2000, the NO_x emission levels should be less than 2,000 mg/Nm^3 (at 15% Oxygen) [Source: Pollution prevention and abatement handbook, World Bank, 1998; as downloaded from http://wbln0018.worldbank.org /essd/essd.nsf/docs.PPAH on May 2002].

Table2.6 Comparison of engine emissions against the relevant standards/guidelines

Parameter	Emissions from MAN engines	Emissions from Mirrlees engines	Emission standard/ guideline
Solid particles	139 mg/Nm^3	144 mg/Nm^3	200 mg/m^3
Sulphur dioxide	1218mg/Nm^3	991 mg/Nm^3	2000* mg/m^3
Nitrogen Oxides as NO_2	1091 mg/Nm^3	1199 mg/Nm^3	1000 mg/m^3
Carbon Monoxide	51 ppm (58 mg/m^3)	442 ppm (504 mg/m^3)	1000 mg/m^3

* World Bank Guideline

A comparison of the emission levels against the relevant standard/guideline indicates compliance for particulate matter, sulphur dioxide as well as carbon monoxide. In the case of nitrogen dioxide, it may be noted that the observed values are in the range of 1100-1200 mg/Nm^3 and these are within the range of design values. However, these values are above the emission standard prescribed by the government of Mauritius (1000 mg/m^3) but below the guideline set by the World Bank (2000 mg/Nm^3). For diesel engines, the emissions cannot be brought down to the values specified by the standard through any modification in operating condition or the changes in the design. These levels exist for internal combustion engines using fuel oil.

2.3 Meteorological data and analysis

A Meteorological station (Envirotech make) was set up on top of the building housing the Mirrlees engines (Figure 2.6). A data logger continuously recorded the following parameters: a) Wind speed, b) Wind direction, c) Temperature and d) Humidity. Hourly values of these parameters are one of the key inputs for the modelling purposes. The wind rose for the entire duration of monitoring (20-26 March, 2002) as well as for individual days are shown in Figure 2.7 and 2.8.

Figure 2.6 Weather monitoring station established at the Fort Victoria power station

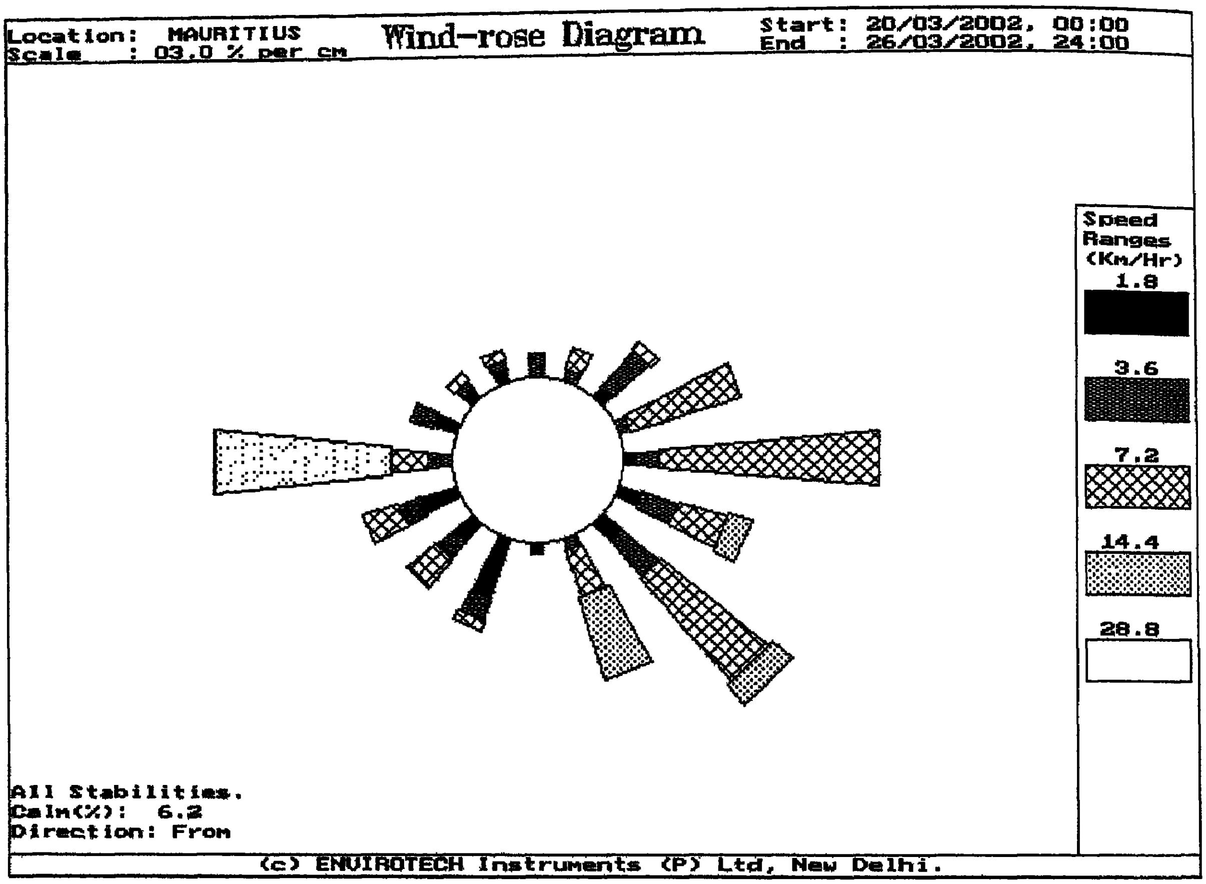


Figure 2.7 Wind rose for the period from March 20-26, 2002 at Fort Victoria Power Station, Cassis

The above indicates that the most prominent wind directions were East (13.8%), South-East (13.1%) and West (13.1%). The directions E and SE are most favourable since the pollutants emitted move towards the Sea. However, the W and NW direction brings the pollutants towards the residential areas.

Based on the data collected, the daily wind roses for the period are also plotted and the same are depicted in Figure 2.8. These correspond to the timings from 7 am (day 1) to 7 am the next day so as to match with the air quality monitoring period.

The wind rose for the different months compiled by the Meteorological service, Government of Mauritius based on observations at Fort William (1996-2000), indicates that SE and E are the most prominent wind directions in the area (Annexure 2.6).

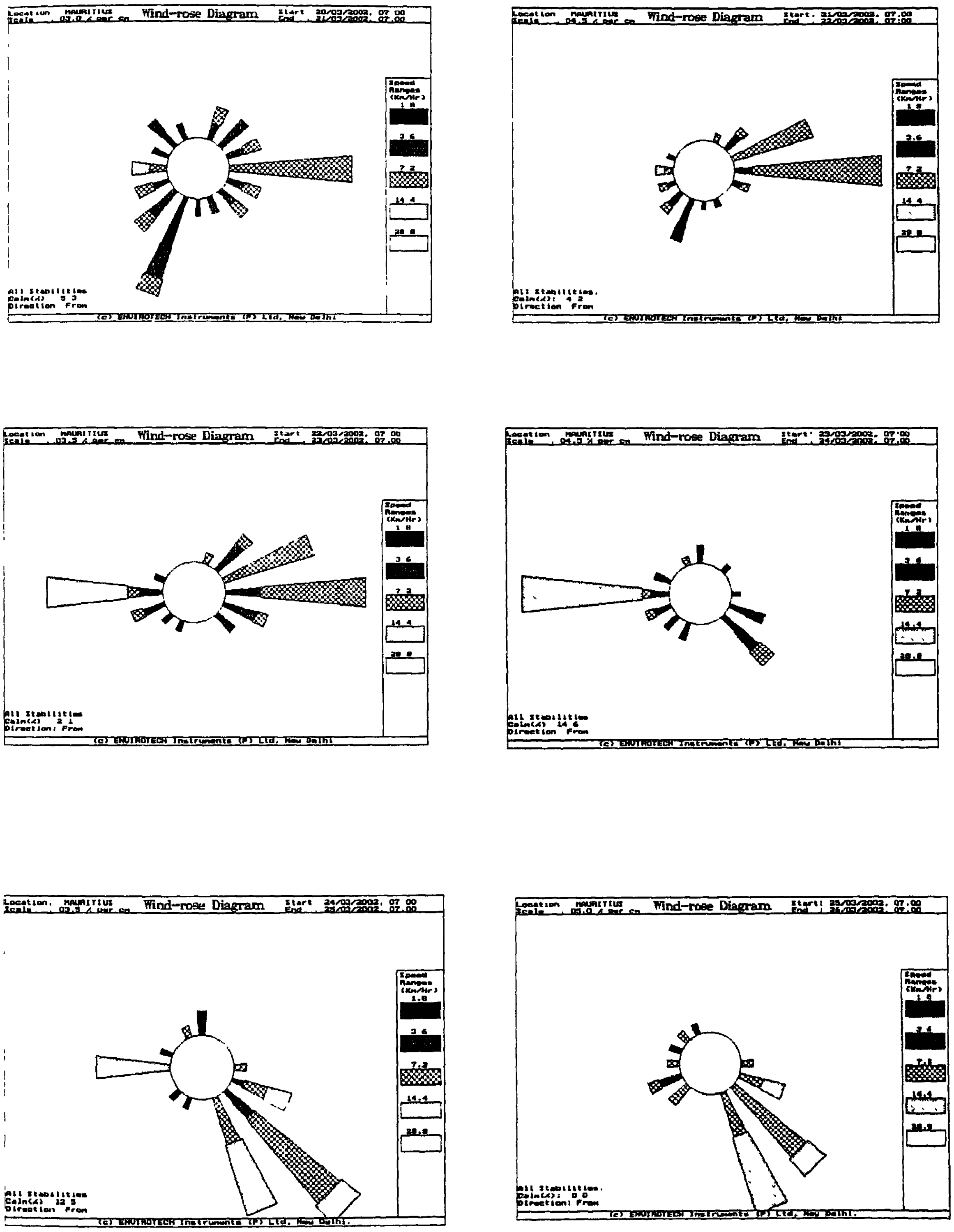


Figure 2.8 Daily wind roses for the period March 20 to March 26, 2002

2.4 Ambient air quality (AAQ)

Based on the wind rose information collected from Meteorological service, Government of Mauritius, layout of nearby residential areas, information regarding complaints from neighbourhood, and representativeness of the stations, a total of six locations were selected for ambient air quality monitoring. The details for the same are given in Table 2.7 and the locations are indicated in Figure 2.9.

Table 2.7 Location of ambient air quality stations

Station number	Location
A1	CEB store room
A2	House opposite to the CEB main gate
A3	CEB house in locality (just outside the electric workshop)
A4	Mauritius Telecom office building
A5	Mr Boodhun's House
A6	Mr Sundaram's house (background station)

The power plant officials were requested to operate the plant for 24 hours on the monitoring days for representative sampling, but that was not possible due to the operating restrictions on the plant. Thus, keeping in view the operating hours permitted for the Fort Victoria Power Station, the monitoring schedule was designed accordingly into three shifts beginning at 7 am in the morning. The daily average values are based on the average of the three shifts. The parameters SPM, SO_2, and NO_2 were monitored as per the above shifts for the period March 20-25, 2002. In addition, measurements of RPM (Respirable Particulate Matter or PM_{10}) were also taken since the finer particles are important from the point of view of health impacts.

The measurement method for SPM and RPM (PM_{10}) was based on High-Volume sampler, while that for SO_2 and NO_2 was based on Calorimetry (West and Gaeke method), and Sodium Arsenite method, respectively. In addition, CO measurements (instantaneous values) were measured at different times during the day for two consecutive days (25th and 26th March, 2002) at each of these AQ stations. These were recorded using CO monitor (Drager make).

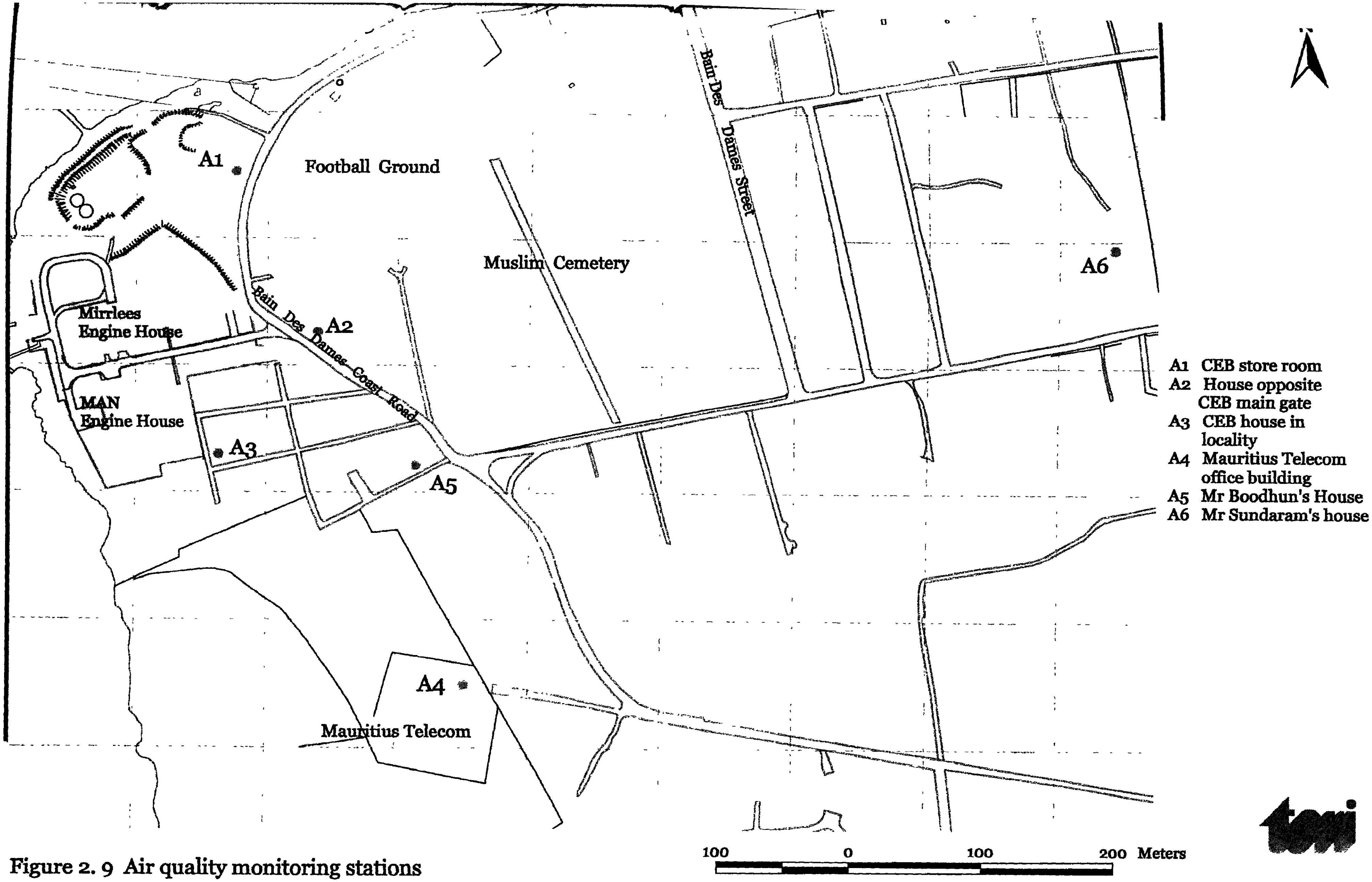


Figure 2. 9 Air quality monitoring stations

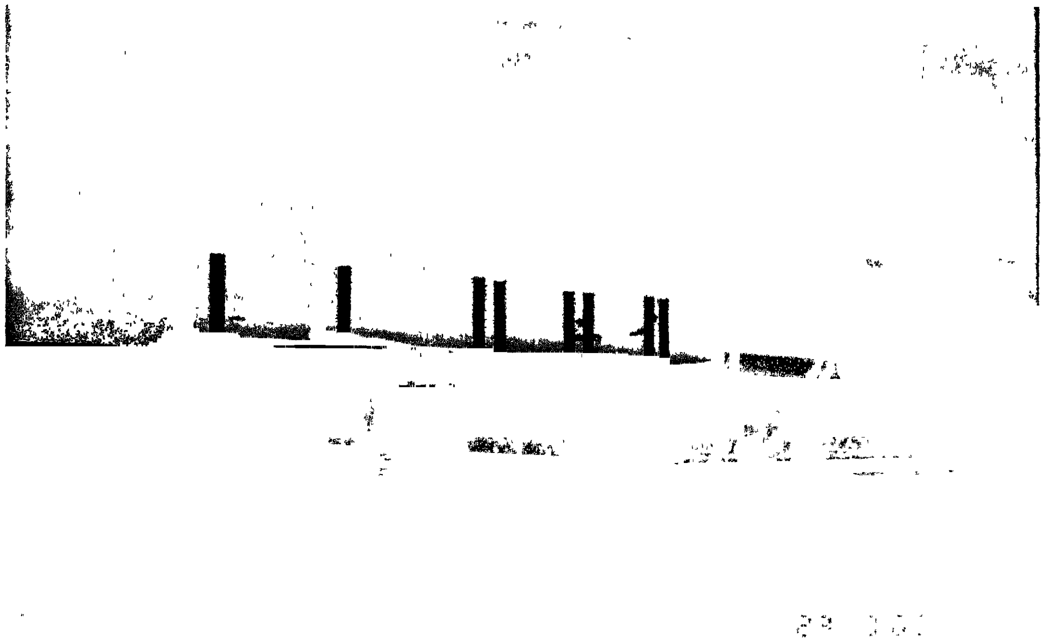


Figure 2.10 Ambient air quality monitoring station at CEB store room Fort Victoria Power Station

The 24 hourly averaged ambient air quality values are given in Table 2.8, while the shift-wise observations for each day are given in the Annexure 2.7. Further, Table 2.9 shows the instantaneous observed values for CO, which are all in the low range.

Table 2.8 Ambient air quality in and around Fort Victoria Power Station during the period March 21-25, 2002

Date	Location	RPM ($\mu g/m^3$)	SPM ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)
20/03/02	Mauritius Telecom office	19	55	19	50
	Mr.Boodhan's house	32	75	6	18
	CEB house in locality	32	46	7	34
	Mr. Sundaram's house	13	25	8	39
	House opposite to the CEB maingate	17	31	6	40
	CEB store room	18	43	8	45
21/03/02	Mauritius Telecom office	16	40	10	29
	Mr.Boodhan's house	24	51	12	42
	CEB house in locality	13	31	8	16
	Mr. Sundaram's house	14	23	10	45
	House opposite to the CEB maingate	10	18	7	25
	CEB store room	15	31	6	19

Date	Location	RPM ($\mu g/m^3$)	SPM ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)
22/03/02	Mauritius Telecom office	15	20	5	27
	Mr.Boodhan's house	20	38	6	32
	CEB house in locality	13	22	7	45
	Mr. Sundaram's house	10	27	7	30
	House opposite to the CEB maingate	10	21	7	30
	CEB store room	10	32	10	33
23/03/02	Mauritius Telecom office	20	31	6	36
	Mr.Boodhan's house	26	44	10	42
	CEB house in locality	14	23	11	33
	Mr. Sundaram's house	11	20	10	43
	House opposite to the CEB maingate	17	26	11	36
	CEB store room	-	27	14	47
24/03/02	Mauritius Telecom office	18	30	9	32
	Mr.Boodhan's house	19	29	7	35
	CEB house in locality	11	21	8	37
	Mr. Sundaram's house	16	20	8	37
	House opposite to the CEB maingate	16	25	7	42
	CEB store room	-	28	9	46
25/03/02	Mauritius Telecom office	14	29	5	28
	Mr.Boodhan's house	23	51	10	37
	CEB house in locality	13	31	8	29
	Mr. Sundaram's house	24	28	9	34
	House opposite to the CEB maingate	13	34	7	38
	CEB store room	38	50	15	51

The above table indicates that the range of the 24 hourly values at the various stations are 10-38 $\mu g/m^3$ for RPM against the standard of 100 $\mu g/m^3$; 18-75 $\mu g/m^3$ for SPM against the standard of 150 $\mu g/m^3$; 5-19 $\mu g/m^3$ for SO_2 against the standard of 200 $\mu g/m^3$; and 16-51 $\mu g/m^3$ for NO_2 against the standard of 200 $\mu g/m^3$. Thus, the 24 hourly values were all within the ambient air quality standards during the period of monitoring. However, it is important to keep into consideration that the power plant operated only from 7 am – 9 pm (as per the government restrictions) and did not operate round the clock.

Table 2.9 Ambient CO observations in and around Fort Victoria Power Station

Date	Location	Time	CO (ppm)
25/03/02	Mauritius Telecom office	4pm - 5pm	3
	Mr.Boodhan's house		2-3
	CEB house in locality		10-11
	Mr. Sundaram's house		15
	House opposite to the CEB maingate		10

Date	Location	Time	CO (ppm)
	CEB store room		10
25/03/02	Mauritius Telecom office	8pm-9pm	4
	Mr.Boodhan's house		3
	CEB house in locality		4-6
	Mr. Sundaram's house		12
	House opposite to the CEB maingate		2-3
	CEB store room		8-10
26/03/02	Mauritius Telecom office	7am-8am	0
	Mr.Boodhan's house		2
	CEB house in locality		3-4
	Mr. Sundaram's house		2
	House opposite to the CEB maingate		1
	CEB store room		2-3
26/03/02	Mauritius Telecom office	6pm -7 pm	2
	Mr.Boodhan's house		2
	CEB house in locality		2-3
	Mr. Sundaram's house		0
	House opposite to the CEB maingate		0
	CEB store room		2-3

2.5 Noise pollution

2.5.1 Introduction

The sounds that a normal human ear can hear cover a range from 20 micropascals to about 600 pascals. Such a range would be difficult to describe using fundamental units, so the Decibel is used to compress this range. The decibel (dB) in acoustics is defined as the log of the ratio between the noise being measured and a reference level. The reference level is chosen as 20 micropascals, the approximate lower limit of human hearing. The use of logarthims also fits in well with the actual hearing mechanism of the ear which is itself logarthimic. Thus the decibal is a good description of the noise level.

The apparent loudness of a sound (i.e., the subjective evaluation made by the human ear) varies with frequency as well as with sound pressure. Compared with the response to the sounds in the frequency range 250 to 8000 Hz, the ear is less sensitive at other frequencies. To adjust the frequency response of measuring systems to be similar to that of the human ear, several weighting curves have been proposed. The trend is towards the exclusive use of the 'A' weighting curve to noise measurements associated with diesel engine applications. When the term 'Sound Level' is used, it always implies a weighting and the results are in dB(A).

Noise in the environment has been identified as one of the main problems which reduces the quality of life and it is the subject of an increasing number of complaints from the public. Problems associated with noise include annoyance, sleep disturbance and other auditory and non-auditory physiological effects. The impact of noise pollution on the neighbourhood community depends on the i) characteristics of the noise source – intermittent or continuous in nature, ii) the time of the day at which noise occurs. Noise levels at night are more annoying than in day because of sleep disturbances and iii) the location of the noise source as well as the receptors. A steady noise is not as annoying as one that is continuously varying in loudness.

The Ministry of Environment, Government of Mauritius has notified the environmental standards for noise in 1997 under the Environment Protection (Environmental Standards for Noise) Regulation 1997 (Annexure 2.8). In these regulations, 'dB(A) L_{eq}' means the equivalent A weighted sound pressure level measured in decibel. The details are given in Table 2.10.

Table 2.10 Noise exposure limits

Category	Time (in hrs)	Noise exposure limits dB (A) L_{eq}
Industrial noise	0700 - 2100	60
	2100 - 0700	55
Neighbourhood (residential area)	0700 - 1800	60
	1800 - 2100	55
	2100 - 0700	50

Note. Apply a tonal character adjustment of + 5 dB(A) to the measured value where the noise has a definite continuous note such as a whine or a hiss.

The tonal character adjustment of +5 dB(A) is not significant in this case as the power station emits continuous wide-band noise which does not contain definite notes like whine and hisses.

2.5.2 *Noise monitoring survey*

As a part of the environmental assessment study, noise monitoring was carried out to assess the extent of noise pollution impact on the population in the neighbourhood due to the operation of the power station. An impact zone of one kilometer from the power plant was considered but emphasis was laid on the residences in the immediate vicinity of the power station. The layout of the power plant and the surrounding area is such that neighbourhood residential area starts immediately after the boundary wall in two directions namely South East & East.

After a survey of the study area and based on discussions with the power station officials, 11 stations were selected for noise monitoring. The layout map of the study area and location of noise level monitoring stations are given in Figure 2.11. The details are as given in Table 2.11.

Table 2.11 Location of noise level monitoring stations

Station No.	Station name	Approximate distance from (metres)	
		MAN engine house	Mirrlees Engine house
N1	MAN engine house, inside	-	116
N2	MAN engine house, outside	-	-
N3	Mirrlees engine house, inside	116	-
N4	Mirrlees engine house, outside	-	-
N5	In front of electrical sub-station (boundary of the plant)	58	77
N6	Near lab building (boundary of the plant)	130	17
N7	Residential, towards MAN station (CEB house)	91	126
N8	Residential, towards Mirrlees station (House opposite to the CEB maingate)	165	82
N9	Residential area (Mr. Sundaram's house), near western cementry	765	677
N10	Football play ground, at a distance of about 1m from highway	765	804
N11	Football play ground at a distance of about 50m from highway	708	745

The noise measurements were done with a calibrated sound level meter (CIRRUS type) covering typical locations like the vicinity of the noise source; the boundaries of the power plant, nearby and distant residential locations in the impact zone. The measurements were done at each station for a particular time interval, say 15 minutes, every one hour, from 7 AM to 10 PM using the dB(A) scale of the Sound Level Meter (SLM) and the equivalent sound level L_{eq} was calculated for each location. The noise meter was kept at 1.5 m above the ground and about 1 m from walls, buildings or other sound reflecting sources. The energy equivalent sound level, L_{eq}, equals the constant sound level whose acoustic energy is equivalent to the acoustic energy of a fluctuating sound over some time interval. L_{eq} was calculated for day, evening and night hours for each station and are given in Table 2.12. In each case the operating conditions of the plant were recorded. The details of the recorded observations at each station are given in Annexure 2.9. Isophones depicting the noise levels have been plotted for day, evening and night hours and are given in Figures 2.12, 2.13 and 2.14.

Table 2.12 Ambient noise levels at various stations L_{eq} dB(A)

Station no.	Date	Day L_{eq} dB(A)	Evening L_{eq} dB(A)	Night L_{eq} dB(A)*	Remarks
N1	20.3.02	104.9	--	78.3	4 Mirrlees & 2 MAN running
N2	20.3.02	80.9	--	69.2	-do-
N3	22.3.02	99.1	--	72.5	5 Mirrlees & 2 Man running
N4	22.3.02	73.5	--	66.2	-do-
N5	20.3.02	67.9	68.0	48.8	4 Mirrlees & 2 MAN running
N6	22.3.02	68.9	--	--	5 Mirrlees & 2 MAN running
N7	23.3.02	58.3	58.6	50.6	5 Mirrlees + 2 MAN 5 Mirrlees + 1 MAN (Ev)
N8	21.3.02	66.0	67.8	48.0	6 Mirrlees & 2 MAN
N 9	24.3.02	49.5	66.2	43.1	1 Mirrlees + 1 MAN, 1 MAN only (Eve.)
N10	24.3.02	76.1	66.6	52.9	1 Mirrlees + 1 MAN, 1 MAN only (Eve.)
N11	24.3.02	60.1	66.0	64.3	1 Mirrlees + 1 MAN, 1 MAN (Eve.)

Note. 1. Night time - No engine running; Day 7 am - 9 pm (within plant); Day 7 am - 6 pm (Neighbourhood) Evening hours: 6 pm - 9 pm (Neighbourhood); Night hours: 9 pm - 7 am.

2. Night observations were taken immediately after 9 pm (when the engines are shut down), the noise levels indicated in the table are higher. This could be due to running of some accessories for some time before complete shut down.

The 11 monitoring stations can be grouped under five categories namely inside engine houses, outside engine houses, boundary of the power station, nearest residences and within the impact zone. The two stations N10, N11 are near the highway and represent the noise levels due to highway traffic. The highway noise has no influence on the residents in the immediate neighbourhood of the power plant. The noise levels L_{eq} dB(A) for day, evening and night hours at typical locations in and around the power plant are given in Table 2.13.

Table 2.13 Measured noise levels (L_{eq}) at typical locations in and around the Power Station at Fort Victoria

	Noise level dB(A) (L_{eq})			
Location	Stations	Day	Evening	Night$^+$
Near the source (≅ 1 m)	N1, N3	99-105	-	72-78
Just outside engine house	N2, N4	74-78	-	66-69
At the Boundary	N5, N6	68-69	68	49
At the nearest residences (≅ 150m)	N7, N8	58-66	59-68	51
Within the impact zone (≅ 750 m)	N9	49	66	43

Note. $^+$No engine operating during night

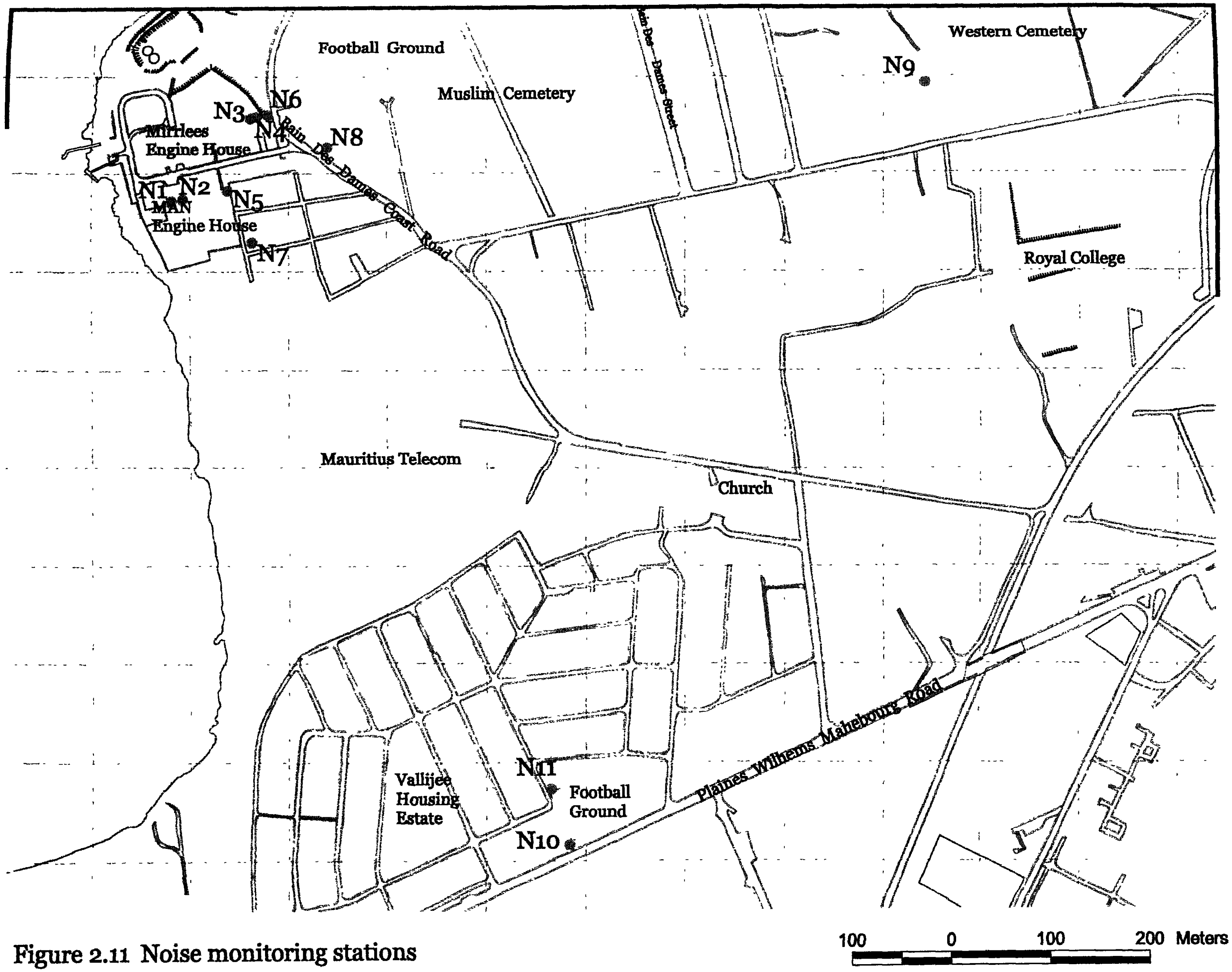


Figure 2.11 Noise monitoring stations

N1. MAN engine house, inside
N2. MAN engine house, outside
N3. MIRRLEES engine house, inside
N4. MIRRLEES engine house, outside
N5. In front of electrical sub-station
N6. Near lab building
N7. Residential, towards MAN station (CEB house in locality)
N8. Residential, towards MIRRLEES station (House opposite to the CEB maingate)
N9. Residential area (Mr. Sundaram's house, near western cementry
N10. Football ground at a distance of about 1m from highway
N11. Football ground at a distance of about 50m from highway

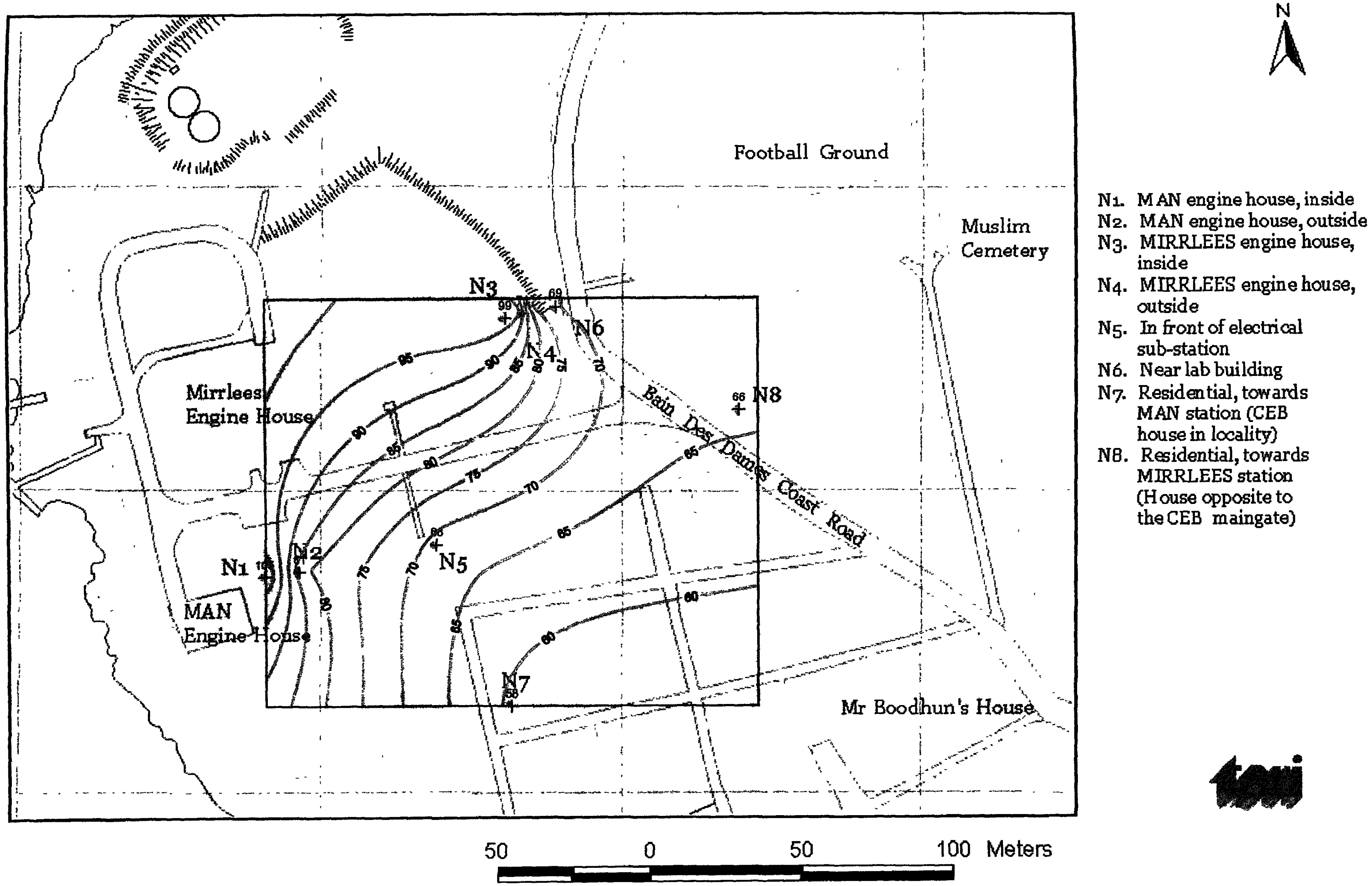
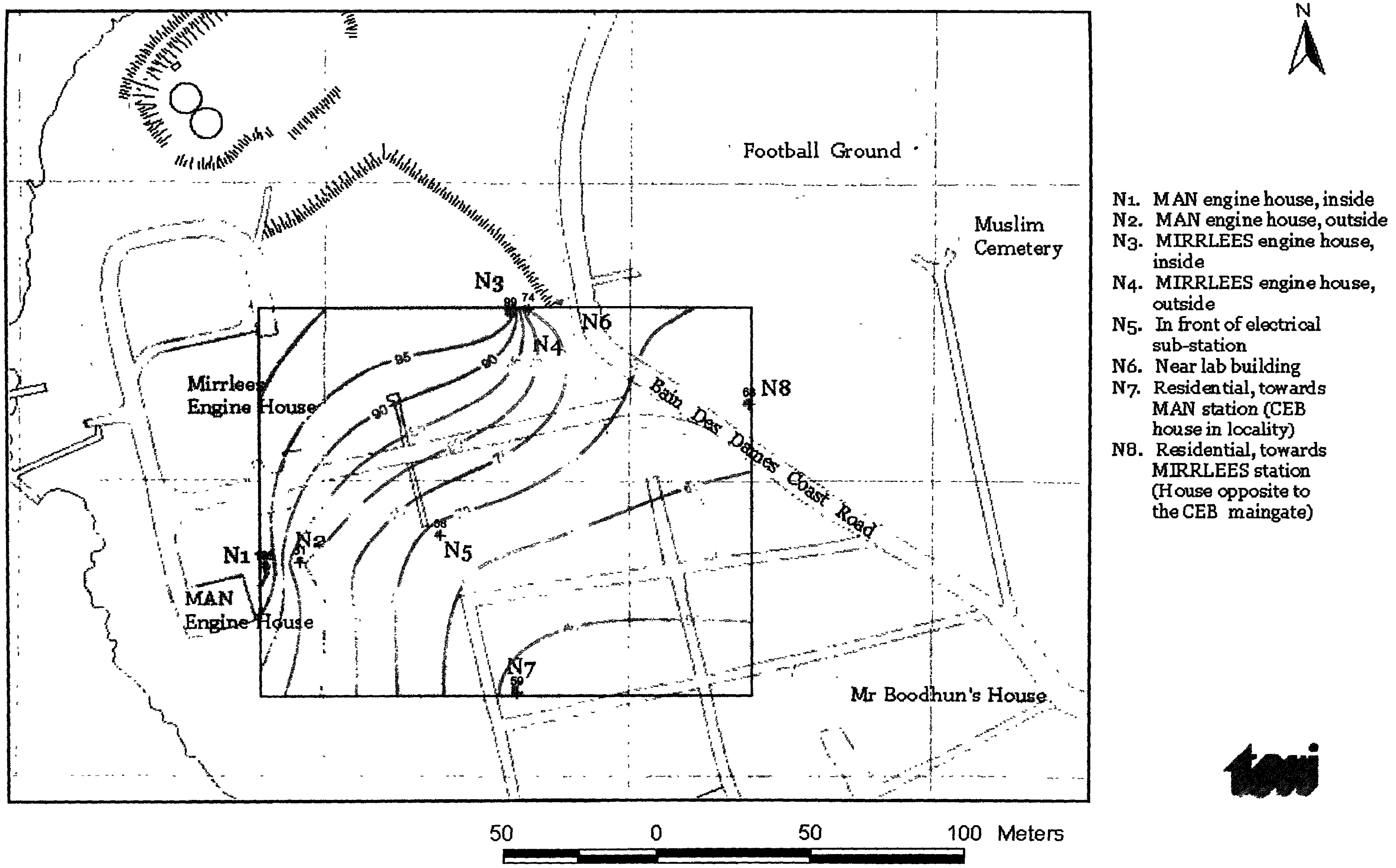

N
Football Ground
Muslim Cemetery
Mirrlees Engine House
MAN Engine House
Mr Boodhun's House
Bain Des Dames Coast Road
N1
N2
N3
N4
N5
N6
N7
N8
99
69
66
95
90
85
80
75
70
65
60
50 0 50 100 Meters
N1. MAN engine house, inside
N2. MAN engine house, outside
N3. MIRRLEES engine house, inside
N4. MIRRLEES engine house, outside
N5. In front of electrical sub-station
N6. Near lab building
N7. Residential, towards MAN station (CEB house in locality)
N8. Residential, towards MIRRLEES station (House opposite to the CEB maingate)

Figure 2.12 Isophones:Day time (Fort Victoria power station)



N
Football Ground
Muslim Cemetery
N3
99
74
N6
N4
95
90
90
Mirrlees Engine House
Bain Des Dames Coast Road
N8
68
N2
N1
N5
68
MAN Engine House
N7
59
Mr Boodhun's House
N1. MAN engine house, inside
N2. MAN engine house, outside
N3. MIRRLEES engine house, inside
N4. MIRRLEES engine house, outside
N5. In front of electrical sub-station
N6. Near lab building
N7. Residential, towards MAN station (CEB house in locality)
N8. Residential, towards MIRRLEES station (House opposite to the CEB maingate)
50
0
50
100 Meters

Figure 2.13 Isophones:Evening (Fort Victoria power station)

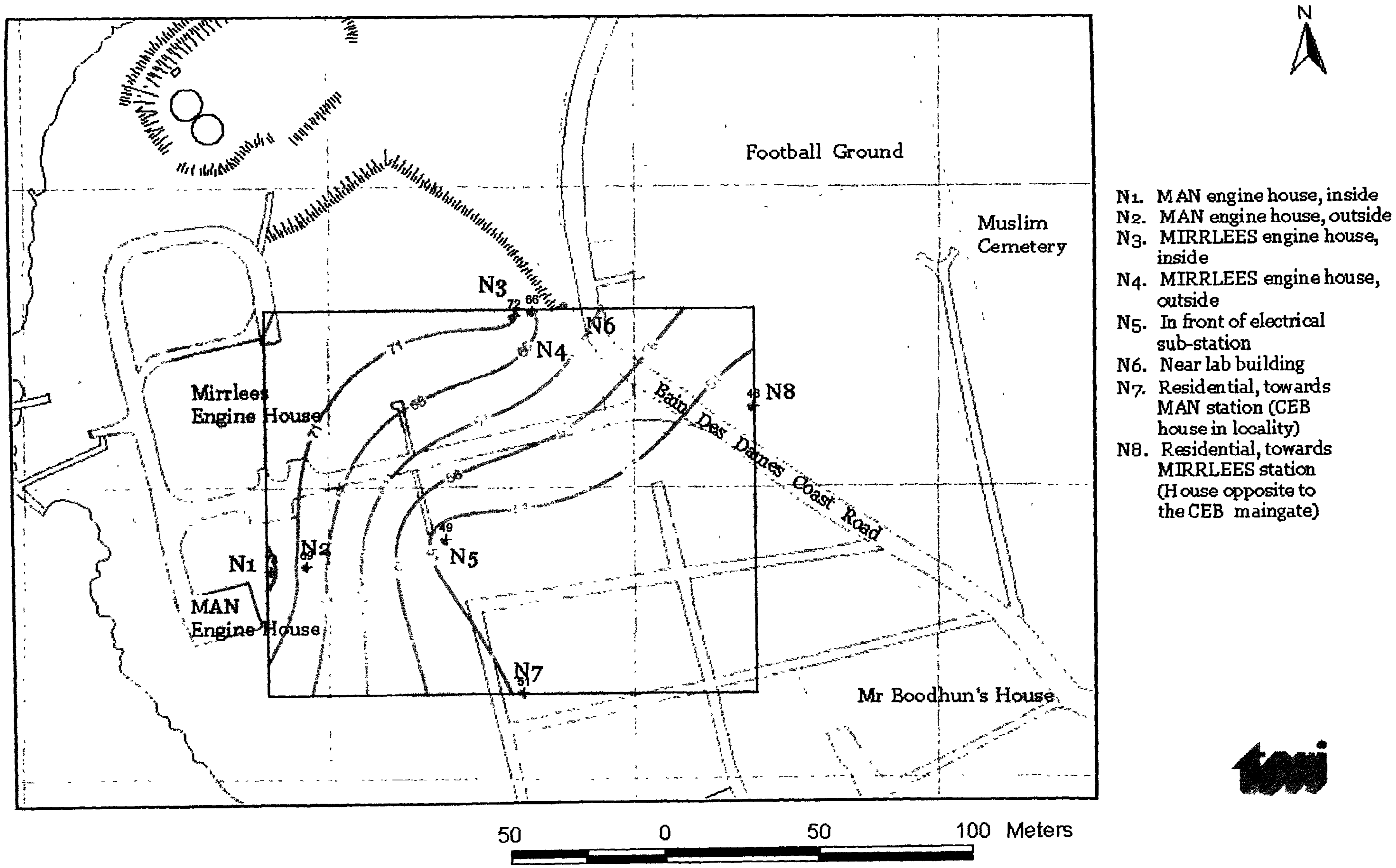

N
Football Ground
Muslim Cemetery
Mirrlees Engine House
MAN Engine House
Bain Des Dames Coast Road
Mr Boodhun's House
N1
N2
N3
N4
N5
N6
N7
N8
72
66
71
49
48
51
N1. MAN engine house, inside
N2. MAN engine house, outside
N3. MIRRLEES engine house, inside
N4. MIRRLEES engine house, outside
N5. In front of electrical sub-station
N6. Near lab building
N7. Residential, towards MAN station (CEB house in locality)
N8. Residential, towards MIRRLEES station (House opposite to the CEB maingate)
50
0
50
100 Meters

Figure 2.14 Isophones:Night (Fort Victoria power station)

?.5.3 *Interpretation of the observed values*

It is seen from the Table 2.13 that the maximum value of measured noise level at the nearest residential location from the plant ($\cong$ 150 m from the source) is 68 dB(A) during day time and evening hours. The average night time noise level at the nearest residence is 51 dB(A), when the engines are shut down. However, the EPA requirement is to meet the neighbourhood noise levels of 60, 55, and 50 dB(A) (L_{eq}) during day, evening and night hours respectively.

2.5.4 *Effect of distance on sound pressure level*

It is important to understand that the sound pressure level relates to the receptor. In free space, the amplitude of the pressure fluctuations decrease in inverse proportion to the distance from the sound source. Consequently the sound pressure level measurements will reduce according to the inverse square law. If a source produces a sound pressure level of 100 dB at 1 m, then the levels measured at increasing distances over free ground or in free space will decrease by 6 dB for each doubling of distance: 94 dB at 2m, 88 dB at 4 m, 82 dB at 8 m etc. The equation for the sound pressure level at point 2 knowing the value at point 1 is

$$L_{p2} = L_{p1} - 10 \text{ Log}_{10} (r_2/r_1)^2$$

Where Lp = Sound pressure level
r = distance from sound source

The noise measurements at various locations show that the observed noise levels nearly follow inverse square – law requirement of 6 dB decrease for every doubling of distance until the engine noise merges with the background noise. Taking the engine noise level of 105 dB(A) at 1 m distance from the source, the expected value of engine noise level at 800 m (Location N9) is around 47 dB(A) against the observed value of 50 dB(A). Thus the noise level at the edge of the impact zone will just merge with the background noise level.

2.5.5 *Noise level measurements at selected locations under different combination of engines operating*

CEB officials suggested that we should monitor noise levels at selected locations under different scenarios of engines operations. Noise measurements were recorded under different combinations of engines running (both MAN and Mirrlees). These observations were taken at 4 locations, 2 near the plant boundary and 2 in the residential area. These locations are:

- Plant boundary near MAN (in front of electrical substation) – N5

- Plant boundary near Mirrlees (near lab building) – N6
- CEB house in locality – N7
- Mr.Boodhan's house

The scenarios for which these observations were taken are as follows:

- No engine running
- All Mirrlees and both MAN engines (A)
- All Mirrlees and 1 MAN engine (B)
- Both MAN engines (C)
- Only 1 MAN engine (D)
- All Mirrlees only (E)
- 1 Mirrlees and both MAN engines (F)
- 1 Mirrlees and 1 MAN engine (G)
- 1 Mirrlees only (H)

The results are given in Table 2.14. The details of the recorded observations are given in Annexure 2.10.

Table 2.14 Noise levels at selected locations with different Scenarios L_{eq} dB(A)

Station number	Timings	No Engine	All Mirrlees & 2 MAN (A)	All Mirrlees & 1 MAN (B)	Two MAN (C)	One MAN (D)	All Mirrlees & No MAN (E)	1 Mirrlees & 2 MAN (F)	1 Mirrlees & 1 MAN (G)	1 Mirrlees & No MAN (H)
N 5	Day	51.4	68.1	66.3	65.7	65.6	64.1	65.9	62.5	--
	Evening / Night	53.5	69	67.7	67.2	61.2	63.3	68.1	63.9	55.6
N 6	Day	46.9	69	68.8	53.6	56.7	68.9	65.7	65.3	--
	Evening / Night	46.6	73.1	69.9	53.3	48	72.2	72.4	66.2	65.9
N 7	Day	--	61.7	61.2	60.1	54.2	59.9	58	55	--
	Evening / Night	49.1	67	60.7	62.4	53.1	57.9	63.6	53.8	52.8
Mr.Boodhan's House	Day	--	53.6	51.7	62	54.5	53.1	51.1	50.4	--
	Evening / Night	55.2	54.7	47.5	51.1	50.3	54.9	53.8	51.6	52.4

Note. 1. Day time - Readings were recorded between 7 am to 6 pm; Evening / Night- Readings were recorded between 6 pm – 9 pm and 9 pm – 10.30 pm.

2. Noise from other sources like movement of vehicles, barking dogs and general household/community activities influence the noise levels at residence stations, specially in the evening time.

It can be observed from Table 2.14 that the noise levels (L_{eq}) at the boundary of the plant as well as at the residences in the immediate neighbourhood (N7) are higher than the prescribed standards for all combinations of engines operation. At Mr. Boodhan's residence, the noise levels are generally within the prescribed limits. Mr. Boodhans residence is at a distance of approximately 250 m from MAN engine house and 210 m from Mirrlees engine house.

The noise level measurements at the boundary of the power plant should meet the prescribed standards. These measurements for two stations namely N5 & N6 at the boundary of the power plant are summarised in Table 2.15.

Table 2.15 Noise levels at boundary stations of the power plant under different scenarios [in L_{eq} dB(A)]

Stations	Timings	Scenarios							
		A	B	C	D	E	F	G	H
N 5	Day	68.1	66.3	65.7	65.6	64.1	65.9	62.5	
	Evening / Night	69.0	67.7	67.2	61.2	63.3	68.1	63.9	55.6
N 6	Day	69.0	68.8	53.6	56.7	68.9	65.7	65.3	
	Evening / Night	73.1	69.9	53.3	48.0	72.2	72.4	66.2	65.9

It can be seen from the Table 2.15 that the noise levels (L_{eq}) at the two stations along the boundary of the power plant for different scenarios are in the range of 62.5 to 69.0 dB(A) for day time and 55.6 to 73.1 for evening/night time. Moreover, there is no significant reduction in noise levels due to operating lesser number of engines. The noise levels at the boundary of the plant are higher than the prescribed standards. Therefore, it becomes necessary to adopt suitable control measures in both engine houses to reduce the noise levels. These are discussed in Chapter 4.

2.6 Ground Vibrations Generated by operation of engines

2.6.1 Introduction

It was informed by Fort Victoria Power Station engineers that few houses located at about 50 to 60m away from the boundary wall (area marked X in Annexure 2.11) have reported falling-off of plaster on the walls. TERI team was asked to examine whether this has any correlation with the noise and vibrations from the engines at the power station.

All high speed rotating machines produce vibrations in lateral and axial directions. The magnitude and frequency of the vibration depends upon the design criteria like weight, speed, materials employed etc. The machines are anchored on the properly designed foundations, so that the machine itself vibrates within the permissible limits, and the transmission of the vibrations to the ground is also within the permissible limits. All the factors are taken care during the design and construction stage of the foundations of the machine.

After this stage, if the problem persists, it becomes extremely difficult or virtually impossible to find a solution.

The manufacturers of the engines were approached to provide the test-bed data for the engines; a copy of the letter was also sent to CEB. However no response was received from them. Thus, the remarks/suggestions given in this chapter are purely qualitative, based on scientific/engineering knowledge.

2.6.2 Ground vibrations generated by MAN engines

Efforts were made to get the engine vibrations data recorded by the manufacturer during the test at their works and the site, and the basis of the design of the engine foundations. No data was made available. The only data available at the power station was the foundation drawing. Thus our observations are based on the drawings and the walk-through study around the engines and the basement where foundations are located. The observations are qualitative. The following observations were made:

i) The lengthwise, widthwise and height-wise vibrations of the engines are high

ii) Each engine is placed on two solid concrete blocks, sandwitched with 400 mm spring isolators (Annexure 2.12)

iii) The lower block is resting on the natural rock of the bay (rock or soil data not available)

iv) The top concrete blocks is isolated (all around the engines) from the floor of the power house. Apparently there are no vibrations felt on the floor of the power house.

In view of the above, it is felt that there may be low amplitude and high frequency vibrations of the lower concrete block resting on the rock. These are transmitted under the ground to a long distance away from the power plant. Since the base is a solid rock, very little damping of these vibration takes place and they appear a long distance away, and may cause some minor damage like breakage of plaster etc. But by the time, they surface on the ground, their frequency is also very low and the amplitude is also very small. Normally, these may not cause any damage to the houses or buildings.

2.6.3 Ground vibrations generated by the Mirrlees engines

In this case also no data was provided by the manufacturer. Further no drawings of the old power stations and the foundations of the engines was available at site. The following was observed:

i) The length wise, width wise, and height wise vibrations of these engines is also very high.
ii) Each engine is placed on a solid concrete block resting directly on the ground rock.
iii) Each engine foundation block is isolated all around from the floor of the power house.
iv) There are no isolators/spring dampers provided between the engine and the foundation blocks
v) Ground vibrations are felt on the power house floor, and outside the power house building.

2.7 Health and social impact on the residents

The air quality impacts due to the operation of the power plant on the health of the population in the study area could be broadly assessed by comparing the concentration levels of different pollutants against the standards prescribed by Mauritius Government. As noted earlier, the ambient air quality is well within the standards prescribed by the Mauritius government.

A significant number of people reside in the neighbourhood of the power plant. As per the 2000 population census, 5434 persons reside in the immediate vicinity of the plant (as demarcated in Figure 2.15; *Source:* Central Statistics Office, Government of Mauritius). It may be noted that though on an overall basis, the people are exposed to air quality that is within the 24 hourly standards, there may be short duration instances when the people are exposed to high levels of air pollution, especially when the wind blows towards the residential area.

The major concern of the residents relates to the noise and vibration problems. The residents have complained of hearing impairment as well as damage to their houses in terms of cracks, falling plaster etc. As per the results of the monitoring carried out in the residential areas, the noise levels are above the prescribed standards both during day and evening time which may have health impacts provided the residents are exposed to that noise levels for a period of time. In order to quantify the health impacts, detailed epidemiological studies are required which are beyond the scope of the current study.

2.7.1 Hearing loss

It is clearly established that continued exposure to loud noise causes hearing loss which can lead to hearing handicap and deafness. For instance, a factory worker who is exposed to high noise levels over period of years might experience some hearing loss. It has been demonstrated that the length of exposure is as important as the magnitude of the noise level in producing hearing loss. The Occupational Safety and Health Administration (OSHA) has established noise standards to protect industrial workers from hearing loss. Table 2.16 shows the maximum permissible exposure noise times for industrial workers. The Environmental Protection Agency (USEPA) has recommended that 85 dB(A) be the level not to be exceeded when an individual is exposed to noise for an 8 hour work day in the working environment. The noise exposures (levels and duration) indicated in Table 2.16 are rarely encountered in non-occupational noise situations.

Table 2.16 Permissible noise exposure times for occupational noise levels

Maximum duration per day (h)	Sound level dB(A)
8	90
6	92
4	95
2	100
1	105
½	110
¼ (or less)	115

Since the noise levels inside the engine house are above the USEPA occupational standards, thus, it is important that appropriate precautions need to be taken. These may include rotation of staff, use of earmuffs and working from the operators cabin. The CEB employees are already equipped with protective equipments such as earmuffs as per existing legislation. Operator's cabin are also in place in both the engine houses.

In the residential area, the recorded noise levels mainly lead to annoyance, sleep disturbance, lack of concentration, etc. However, during the meeting with the residents, some of them did complaint about hearing problem.

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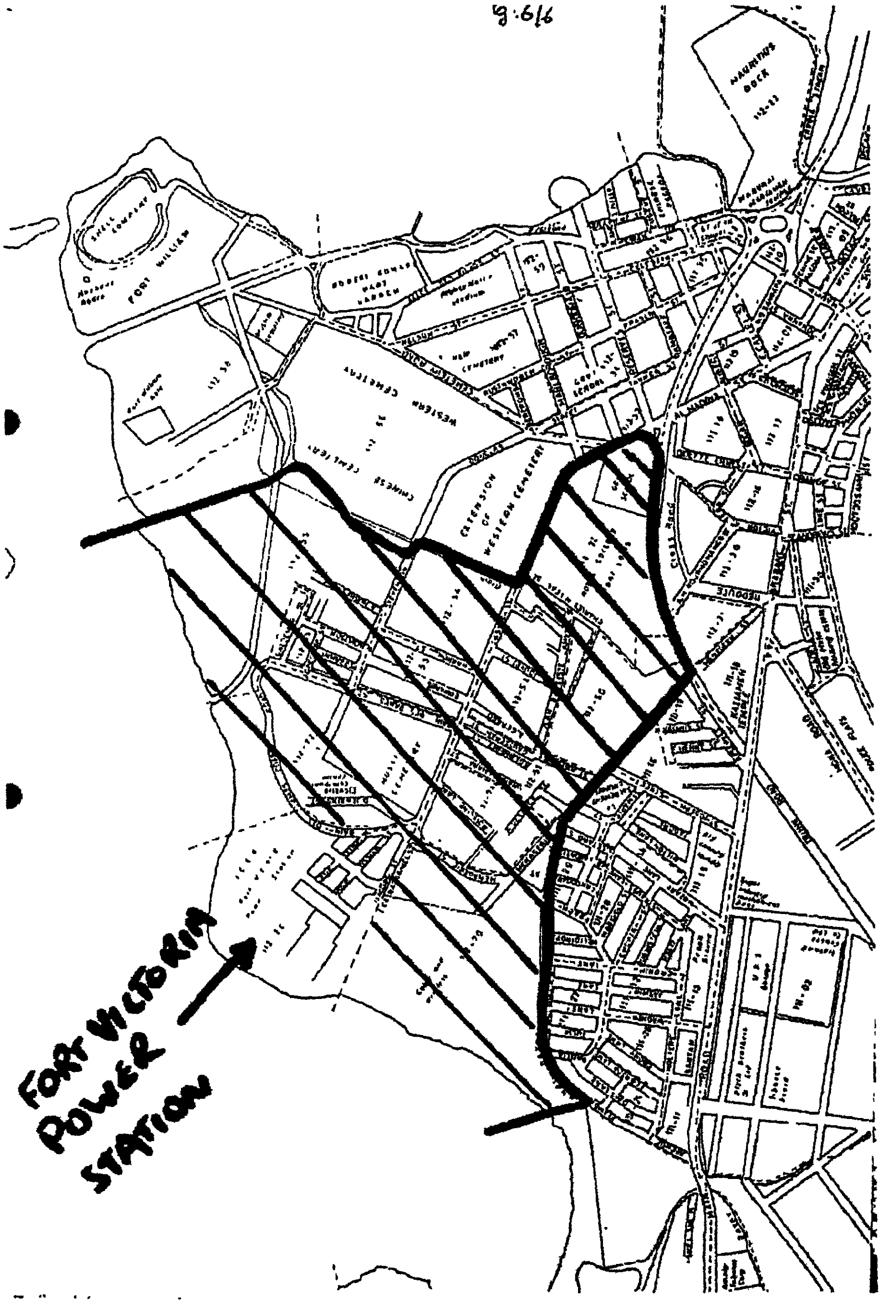


Figure 2.15 Location of residential areas near the Fort Victoria Power Station

3

Environmental impacts: prediction and evaluation

3.1 Assessment of impact on air quality

The information on the existing ambient air quality serves as the background concentration due to all the existing sources of air pollution, including the power plant. As discussed in the previous section, a comparison of the existing ambient air quality against the relevant 24 hourly standards does not show any exceedances. Thus, it may be interpreted that the influence of the emissions from the plant in combination with the dispersive properties of the atmosphere is such that the ambient air quality standards are complied with. For easy interpretation, isopleths depicting the various concentration levels have been plotted for a typical day chosen during the monitoring period i.e., March 23, 2002 (since it included periods when the wind direction was towards the residential area and the engines (5 Mirrlees and 2 MAN) also were in operation). These isopleths for SPM, SO_2 and NO_x are depicted in Figures 3.1 to 3.3 which again show the air quality to be well within the ambient standards.

The impacts on the air quality due to the emission sources has also been determined using appropriate mathematical tools such as air quality model. For undertaking the modelling exercise, the PAL model, which is one of the operational model used by USEPA , has been used. [William B.Petersen and E Diane Rumsey. 1987. USER's Guide for PAL 2.0. A Gaussian - Plume Algorithm For Point, Area, and Line Sources. Atmospheric Sciences Research Laboratory, U.S. Environmental Protection Agency. 87 pp. (EPA/600/8-87/009, March 1987)] .

PAL is an acronym for the *Point, Area, and Line* source algorithm. PAL is a method of estimating short-term dispersion using Gaussian-plume steady-state assumptions. The algorithm can be used for estimating concentrations of non-reactive pollutants at 99 receptors for averaging times of 1 to 24 hours, and for a limited number of point, area, and line sources (99 of each type). In the current exercise, 24 hourly ambient concentrations have been computed due to emissions of SPM, SO_2 and NO_x from the stacks of 7 Mirrlees engines and 2 MAN engines. The average emissions data, as discussed in earlier section has been used, and the hourly variation of emissions from point sources have been accounted for based on the engine operation data for each hour.

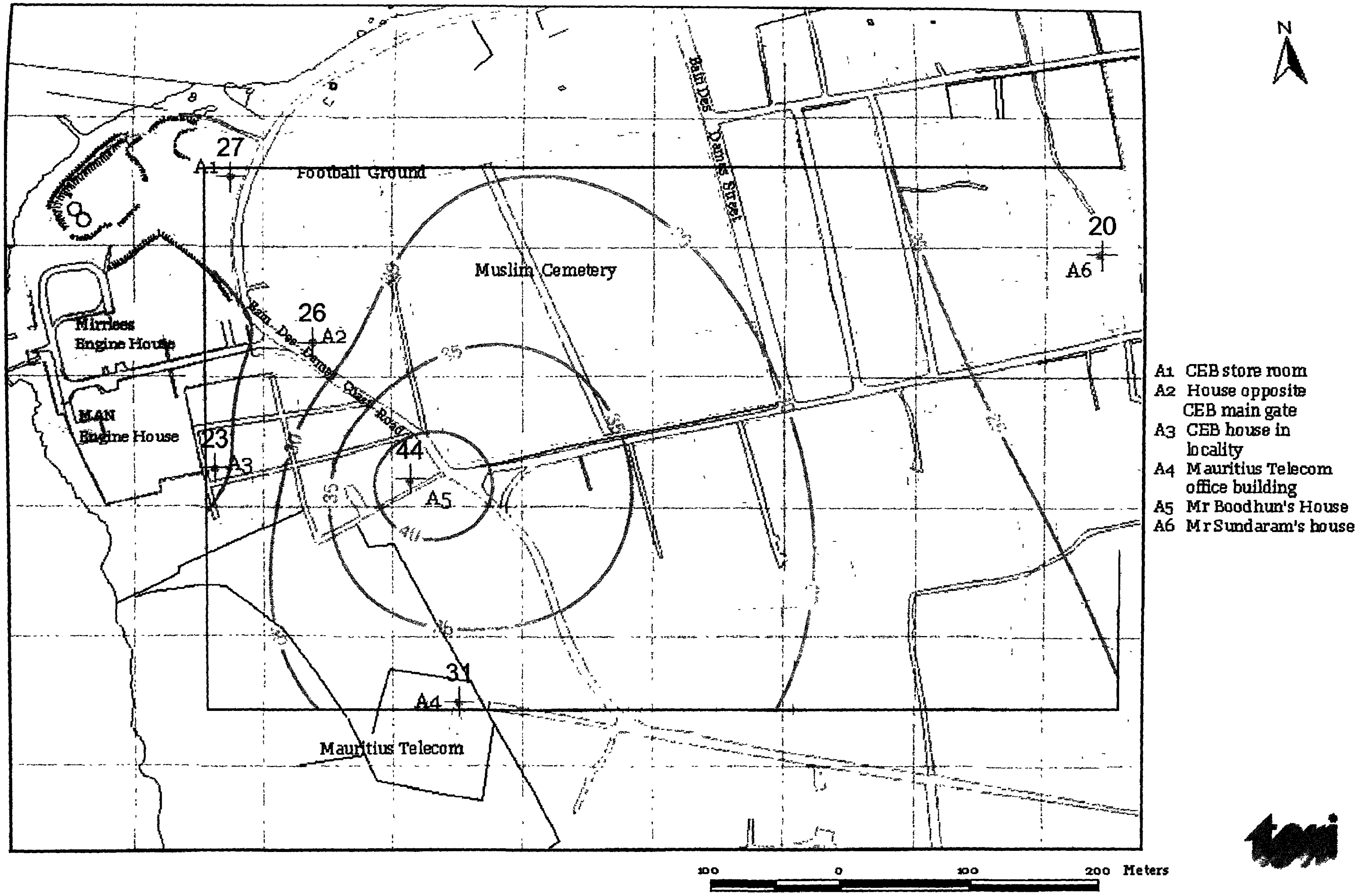
Calculations are performed for each hour. The hourly meteorological data inputs are wind direction, wind speed, temperature, stability class, and mixing height. The stability class has been determined based on the Sigma – Theta ($\sigma\theta$), standard deviation of the wind direction fluctuation method. The mixing height has been determined using the holzworth technique based on the radio sonde profile data obtained from Meteorological Services, Mauritius. The Briggs Urban dispersion parameters are used to characterize dispersion.

The Gaussian point source equation estimates concentrations from point sources after determining the effective height of emission and the upwind and crosswind distance of the source from the receptor. The deposition of both gaseous and suspended particulate pollutants in the plume has also been accounted for.

3.2 Model simulations

The model simulations have been carried out for the following scenarios:

I) For a typical day (March 23, 2002), simulations have been carried out using the actual meteorological onsite information as well as under the hypothetical scenario whereby the wind direction remains constant towards the residents. The other operating conditions remain the same under the two scenarios. The former case denotes the typical scenario, wherein the wind direction changes based on meteorological conditions, and thus ensures dispersion of pollutants in all likely directions. The latter case corresponding to a fixed wind direction (assumed from NW), denotes the worst case to which the residents may be exposed if the wind constantly blows towards them. The ratio of the predicted values under the two scenarios is multiplied by the observed ambient values to obtain the likely concentrations at the 6 air quality stations (A1-A6). Table 3.1 gives the 24-hourly ambient concentrations for SPM, SO_2 and NO_X when the wind blows from the NW direction only. It may be mentioned herewith that it is certainly unlikely that the wind direction will be constant and thus these high ambient values, especially at stations A4 and A5 that lie in the downwind direction, are practically unlikely. Also, note that the stations A1 and A6 are not affected since they do not lie in the direction of the plume.



Fgiure 3.1 Isopleths:SPM (Fort Victoria power station)

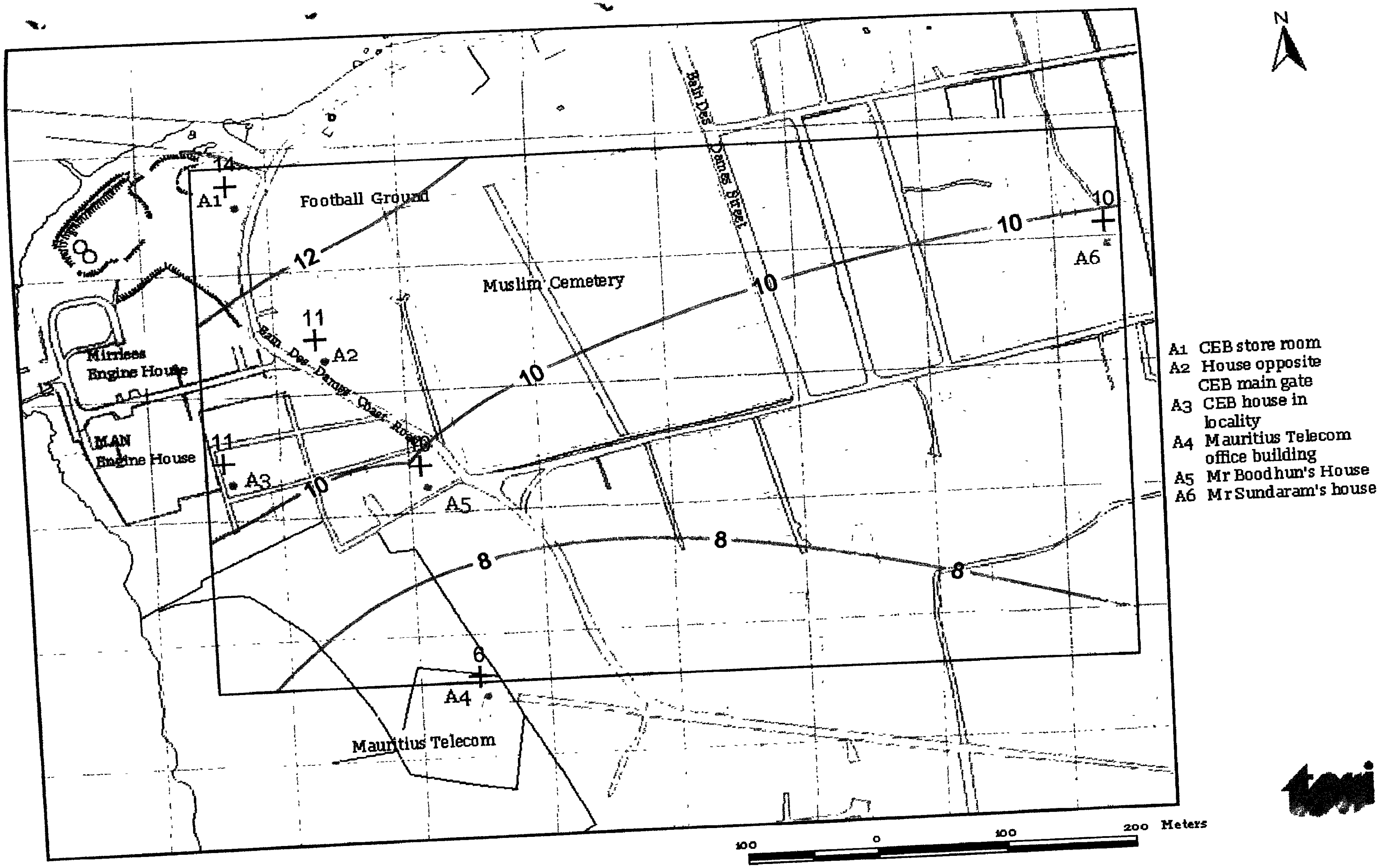


Figure 3.2 Isopleths: SO_2(Fort Victoria power station)

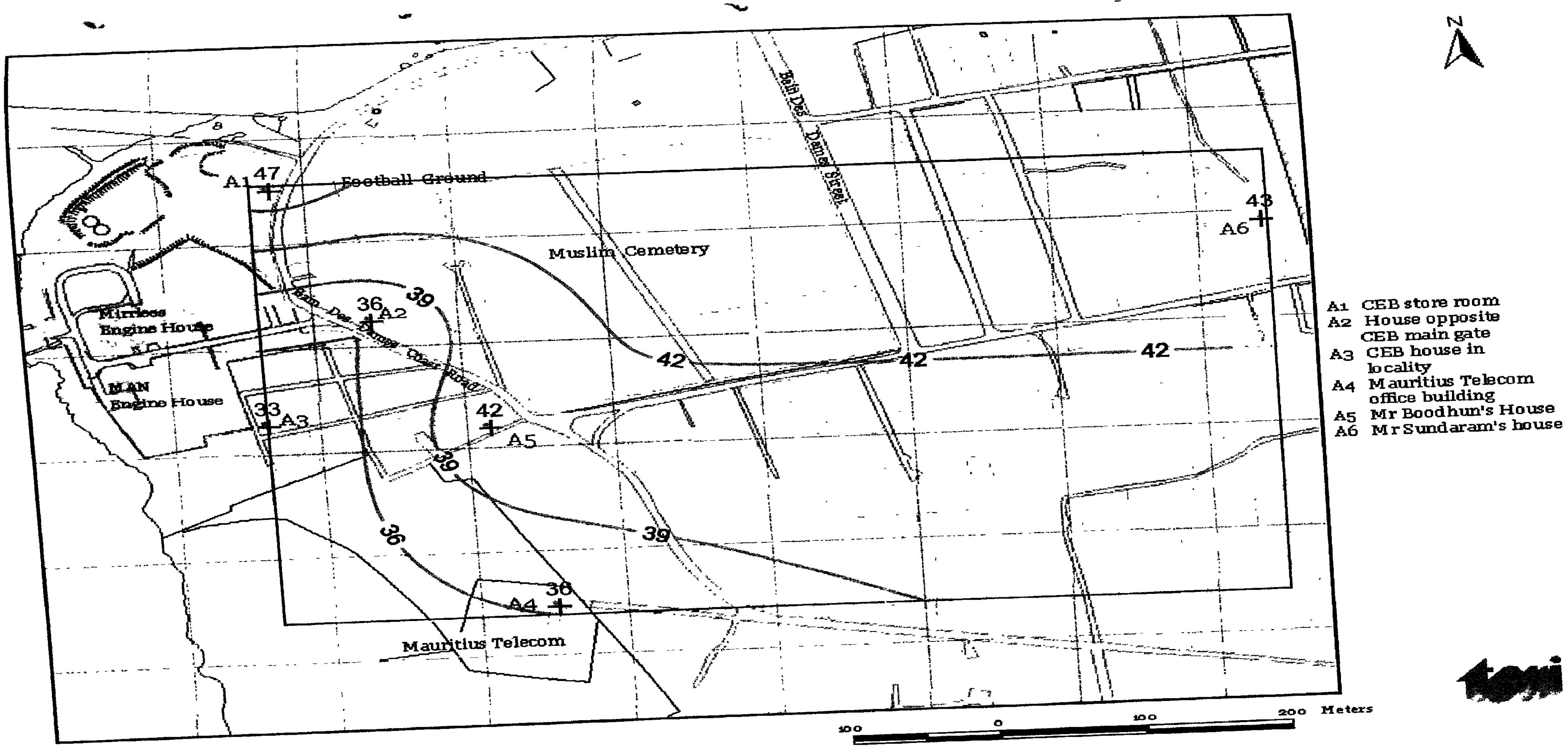


Figure 3.3 Isopleths:NO_2(Fort Victoria power station)

Table 3.1 Hourly ambient concentrations of SPM, SO_2 and NO_X on a typical day under the hypothetical scenario when the wind blows from the NW direction.

Air Quality Station	SPM Concentraion (µg/m^3)	SO2 Concentration (µg/m^3)	NOX concentration (µg/m^3)
A1	0	0	0
A2	9	4	12
A3	97	36	141
A4	3968	618	4608
A5	295	56	291
A6	0	0	0

II) Raising of stack height of the MAN engines.

Based on the information obtained from the Mirrlees engine manufacturers, it was revealed that a 45° bend in relation to exhaust back pressure is approximately equal to 10 diameters. Such a modification has already been carried out in the Mirrlees engines whereby the stack height has been raised after replacing the 45° bend with a discharge tip facing vertically upwards.

Assuming a similar situation with the MAN engines as well, one option is to remove the 45° bend and increase the stack height by 10 times the diameter while ensuring that there is not much effect on the engine performance. Thus, the MAN engines stack height could be raised by about 10.5 – 11.0 meters, assuming the diameter to be about 1.1 meters.

Models simulations have been performed for MAN engine with existing stack height of about 24.5 m above the ground level and the raised stack height option of about 35 m. These simulations have been carried out under various hypothetical meteorological scenarios i.e. unstable and stable conditions with low wind speed, and neutral conditions with high wind speeds. This follows the typical meteorological conditions that exist as per Pasquill's stability classification.

The ambient concentrations at various downwind distances for NO_X for the two different stack heights are shown in Table 3.2. A similar trend is observed for SPM and SO_2 as well.

Table 3.2 Ambient NO_X concentrations due to MAN engine at various downwind distances under different meteorological conditions and stack heights

	Existing stack height - Man (24.5m)			Raised stack height - Man (35.0 m)		
Downwind distance	Unstable 1 m/s	Neutral 5 m/s	Stable 1 m/s	Unstable 1 m/s	Neutral 5 m/s	Stable 1 m/s
100 m	0	232	0	0	77	0
200 m	0	294	0	0	184	0
300 m	0	287	0	0	222	0

400 m	0.5	260	0	1	221	0
500 m	1.5	230	1	2	205	0
600 m	3	202	5	4	186	3
700 m	5	178	17	7	168	9
800 m	8	159	37	10	151	22
900 m	11	141	65	13	136	42
1 km.	14	128	98	17	124	66

An interesting aspect that emerges from the above calculations is that the concentrations are higher at distances closer to the source under high wind speed conditions. This is due to high wind fumigation condition that is more frequently critical for shorter stacks as in the present case. This has significant implications under the current scenario whereby it is observed that the residents staying close to the plant premises experience high concentrations when the wind speeds are high.

Also, the effect of raising the stack height has benefits in terms of ambient air quality, especially under neutral atmospheric stability & high wind speed conditions whereby there is a significant decrease at close distances. The % reduction in concentration under these conditions is 66 % at 100m, 11% at 500 m and 3 % at 1 Km. The computations reveal that under low wind conditions, there is reduction in concentration under stable conditions while under unstable conditions, there is a marginal increase.

Thus, the overall effect of raising the stack height of MAN engines is to significantly decrease the ambient concentration.

It has been established that increase of the stack height for the MAN engines will have a positive effect on the air quality. However, given the fact that the existing ambient concentrations are well within the prescribed standards, it may not be necessary at this stage to increase the stack height. Instead, it is recommended that an ambient air quality monitoring programme may be started in the neighbourhood of the plant premises to ascertain the incidents of non-compliance, if any. This would be particularly appropriate during the months when the wind direction from the NW is relatively more though still not predominant i.e., April, May, November, and December (based on wind rose information at Fort Victoria Power Station, 1996-2000). However, it may be noted that throughout the year, including these 4 months, the predominant wind direction is from the SE that leads to the pollutants being transported towards the Sea.

III) Another hypothetical scenario has been considered whereby it is assumed that the wind blows from a fixed direction, i.e., NW direction, all sources are in operation, i.e., all 7 Mirrlees engines and both MAN engines operate. This is a worst case hypothetical scenario when the pollutants from all the engines are carried towards the residential areas. The computations have been performed for different hypothetical meteorological stability conditions and the ambient concentrations predicted at the 6 air quality stations are shown in Table 3.3.

Table 3.3 Ambient air quality predictions under different hypothetical meteorological conditions assuming constant wind from the NW direction and all engines in operation

Pollutant	Meteorological Scenario	A1	A2	A3	A4	A5	A6
SPM (μg/m^3)	Unstable (1m/s)	0	0	0	18	6	0
	Neutral (5 m/s)	0	115	93	296	460	0
	Stable (1m/s)	0	0	0	10	0	0
SO_2 (μg/m^3)	Unstable (1m/s)	0	2	3	123	43	0
	Neutral (5 m/s)	0	795	658	2152	3195	0
	Stable (1m/s)	0	0	0	69	1	0
NO_x (μg/m^3)	Unstable (1m/s)	0	2	3	151	53	0
	Neutral (5 m/s)	0	967	783	2501	3895	0
	Stable (1m/s)	0	0	0	86	1	0

The above calculations show that maximum concentrations are likely at the stations A4 and A5, which is expected since they happen to be in the downwind direction. Also, due to the NW wind direction, A1 and A6 are unaffected. Due to the high emissions of NO_x and SO_2, the concentrations for these two pollutants are much higher than for SPM, which has a relatively lower emission rate. Also, as discussed earlier, the high wind speed conditions predict very high concentrations at the monitoring stations.

It is clearly evident that under such a scenario, the ambient air quality would be very much exceeding the prescribed standards i.e. 150 μg/m^3 for SPM and 200 μg/m^3 for NO_X and SO_2. However, simultaneously one must keep into consideration that it is practically unlikely that such a scenario would exist. Thus, for the purposes of the existing study, much emphasis should be laid on the observed ambient air quality data that includes a combination of various meteorological conditions that actually exist in reality.

4 Mitigative measures and recommendations

4.1 Air quality

Based on the findings of the study, the following recommendations are made related to the air quality management plan:

1. Use of low sulphur fuels. The power plant is already using a relatively lower sulphur fuel (2.36% S) against the maximum engine design value of 3.5% sulphur. Also, the existing ambient concentration of SO_2 are well within the standards. Thus, the current fuels being used may continue.
2. Raising of stack height
   The MAN stack height could be raised by about 10 meters (by removing the 45 degree bend) and that would have an overall beneficial impact in further improving the existing air quality. However, this measure could be taken if necessary, after a comprehensive air quality monitoring programme.
   The cost estimates for the same could be obtained by CEB from the engine manufacturers, who have not yet responded to the our questionnaire sent to them along with the letter of authorisation from CEB.
3. Air quality monitoring plan
   As noted earlier, it would be better to have a comprehensive air quality monitoring plan in the vicinity of the power station. The efforts should be more concentrated during the 4 months of April, May, November, and December when the incidents of wind direction from the NW are relatively more.

   The number of stations in the residential areas may be 3. The frequency of monitoring suggested is twice a week. The parameters to be focussed are NO_X, SO_2, SPM and PM_{10}. CO may be omitted since the values are very low. Since the Power Station does not have any infrastructure for environmental monitoring, it is suggested that an external agency could be hired to carry out the monitoring task.

   The costs on a per sample basis could be paid along with a lump sum amount for the installation, transportation and operational costs of the instruments. Assuming 3 samples are collected per day for 8 days in a month for a total period of 4 months, the number of samples at the 3 stations work out to be 288. A rough estimate of the per sample cost of all these 4 pollutants (NO_x, SO_2, SPM and PM_{10}) may be taken as US $ 35. The total sample costs work out to be US $ 10080. An additional amount of about 50% of this cost may be taken as the lump sum amount for other miscellaneous expenses. Thus, the total monitoring costs work out to be US $ 15120.

As suggested by the Department of Environment (DoE), a reliable third party could effect the monitoring as proposed. The University of Mauritius could be requested to effect the Ambient air quality monitoring in the vicinity of the station, with the CEB incurring the costs. Additionally the mobile unit of the DOE could be placed in the area twice yearly to verify the consistency of the results.

4.2 Noise pollution

Based on the assessment of the baseline noise quality, one should incorporate noise control measures in and around the power station to achieve additional sound attenuation to ensure compliance with the standards.

The principal sources of noise and vibration from large diesel engines include exhaust noise, inlet noise, fan and accessory noise and vibration; radiation from engine casing due to combustion and due to reciprocating components (valves, crank shaft etc). All of the above sources produce disturbances that can be arbitrarily grouped into two general categories and frequency bands: Noise – 50-20000 Hz, Mechanical vibration – 0 to 50 Hz.

The category of noise can be sub-divided into airborne noise and structure borne noise. Structure borne noise is transmitted along solid structures and is usually generated by a lower frequency vibration source. Testing of airborne noise levels produced by diesel engines has shown that at frequencies below 800 Hz, exhaust, inlet and accessory equipment are the predominant noise sources. Engine casing radiation is the dominant source at higher frequencies, with maximum values usually occurring in the 1000 to 1600 Hz region.

All sound transfer systems break down simply to three elements, viz. the source, the transmission path and the receiver. Sound control measures can be applied at all points in this sound transfer chain so as to obtain the desired results. Among these the noise reduction at the source enjoys top priority.

1. A usual method of controlling noise at the source is to use a total enclosure around the engine with barriers of sound absorbing material to prevent the escape of noise into the environment. It can be built with commercially available modular panels consisting of an outside metal

skin (16 gauge steel), an inner surface of 22 gauge perforated steel (10-30%) open area and the cavity being filled with mineral wool (2-4" thickness with density 60-100 kg/m³). The wool material should be protected by 1-2 mil polyethylene film. The panels are available with double glazed windows and supported with rubber isolator gaskets. However, while designing a total enclosure care must be taken to ensure proper ventilation inside by installing forced air ventilation systems with noise attenuators at the inlet and outlet side. The attenuations obtained by this type of enclosure is about 15 dB in practical situations. These type of enclosures should be provided with sound proof doors for easy accessibility and maintenance purposes.

Areas of heat dissipation, inlet air supply and exhaust need special attention while erecting a total enclosure around the engine. It has also been demonstrated that if as little as 10% of the surrounding space is open, then it will be impossible to reduce the noise level transmitted through the barrier by more than 10 dB. If openings in the barriers are necessary, they should not be straight, line of sight holes, but instead should be as convoluted as possible.

Some firms can tailor-make/design noise control systems as per the specifications specified by the client. One such firm is GERB Vibration Control Systems Pvt. Ltd., 3rd Floor, JOP Plaza, P-2, Sector 18, Noida – 201 301 (UP), India (parent company – GERB Akustik Consult GmbH, Germany).

The list enclosed (refer Annexure 4.1) provides references of Acoustic enclosures installed by M/s. GERB vibration control systems Pvt. Ltd. at various industrial plants in different countries along with the specifications of the acoustic requirements in each case. The list includes various equipments in a power plant such as steam turbine, boiler feed pump, etc.

Some of the references of existing installations in India with technical characteristics are given below:

S. No	Location	Control measures undertaken	Design of Noise absorbing enclosure	Acoustic
1	Bakreswar TPS (Steam Turbine) WBSEB, West Bengal, India	Acoustic enclosure designed for each of the 3 units of 210 MW Steam Turbine. These are self-supporting structures that are designed as individual panel built-up which are easy for maintenance. The fans and	Dimensions (mm) 13700 (W) 32000 (L) 4500 (H) Sandwich Panel construction: 1.5 mm outside CRCA metallic sheet (powder coated), 100 mm mineral wool, 2 mm of glass cloth, 1 mm of perforated	Requirement: 84 dB(A) at 1.5 m Noise reduced from 106 dB(A) to 76 dB(A) Installed

S. No	Location	Control measures undertaken	Design of Noise absorbing enclosure	Acoustic
		the ventilation system are covered with silencers. Enclosures are designed keeping into account the expected rise in ambient temperature by 10-15° C.	sheet GI. The aesthetics and colour choice is taken care of.	
2	Talcher Super Thermal Power Station, NTPC, India	Acoustic enclosures designed for each of the 4 Units of 500 MW Steam Turbine.	Dimensions (mm) 14800 (L) 13000 (W) 5000 (H) Sandwich Panel construction as above	Requirement: 85 dB(A) at 1.0 m Project Under execution
3	DVB Pragati Power Project, Combined –Cycle Gas Based Power Plant, DVB, Delhi	One Steam Turbine of 120 MW	Dimensions (mm) 14800 (W) 13000 (L) 5000 (H) Sandwich Panel construction as above	Requirement: 85 dB(A) at 1.0 m Under execution
4	E.O.C., NTPC, Noida Diesel Generating Sets	One 2000 KVA Diesel Generator of Cummins Make	Dimensions (mm) 9000 (L) 3500 (W) 3200 (H) Specifications: Outer wall of 1.5 mm CRCA Sheet; Double inner lining with highly absorbing mineral wool/rock wool having minimum density of 48 kg/sqm; inside perforated sheets covering the absorbent lining, glass fabric between absorbing material and perforated sheet; proper sealing arrangement in between the panels.	Requirement: 85 dB(A) at 1.0 m. Reduction from 104 dB(A) to 85 dB(A). Tendering process o

Note. L=Length; W=Width; H=Height

2. When a total enclosure is not feasible partial enclosures are sometimes considered. These generally take two practical forms:
    i) Enclosures which totally enclose the major noise source, but not the whole machine
    ii) Enclosures that partially enclose the noise source or the machine.

The effectiveness of the partial enclosure depends upon the acoustic environment as well. In highly reverberant environment, the attenuations provided is not high. In practical situations the normal sound attenuation achieved is about 5-10 dB.

The use of partial enclosures is frequently used in factory environments in India where noisy machines are segregated from one another in order to reduce the overall noise level.

3. The use of acoustical curtains as enclosures or partial enclosures is another popular option. Their popularity is due to their acoustical effectiveness, versatility, and ease of installation. Typical curtain materials include lead on barium loaded Vinyl (surface weight 1 lb/ft^2). The smooth vinyl materials are limp and highly resistant to industrial environments. Typical noise reduction achieved vary from 5-8 dB. Transparent strip curtains are also a popular version.

   The use of acoustic curtains is a common practice in industrial / constructional activities. The pavement repair in residential area in Europe is always done by concealing the noise source (impact hammer etc.) with vinyl (leaded) curtains.

4. The reverberant build-up of sound in large industrial halls is another source of environmental noise as in the present case. This can be avoided partially by acoustically treating the available wall and ceiling surfaces. The treatment takes the form of perforated metal sheets (30% open area) on 50 mm air gap with 50 mm thick mineral wool enclosed in polythene bags (60 kg/m^3 density) filled in the cavity. The sound pressure level reduces by 3 DB for each halving of the reverberation time.

   Such treatments are very common in most air conditioning plant rooms in India.

5. When wall or ceiling surfaces are not available for acoustical treatment then functional or space absorbers are often used to introduce additional absorption in the hall. These take various forms as shown in Figure 4.1. These are made of glass wool sheets enclosed in wirenet cases and suspended above the offending noise sources in the hall. Sound absorbent baffles can also be suspended above noise sources to reduce reverberant build up.

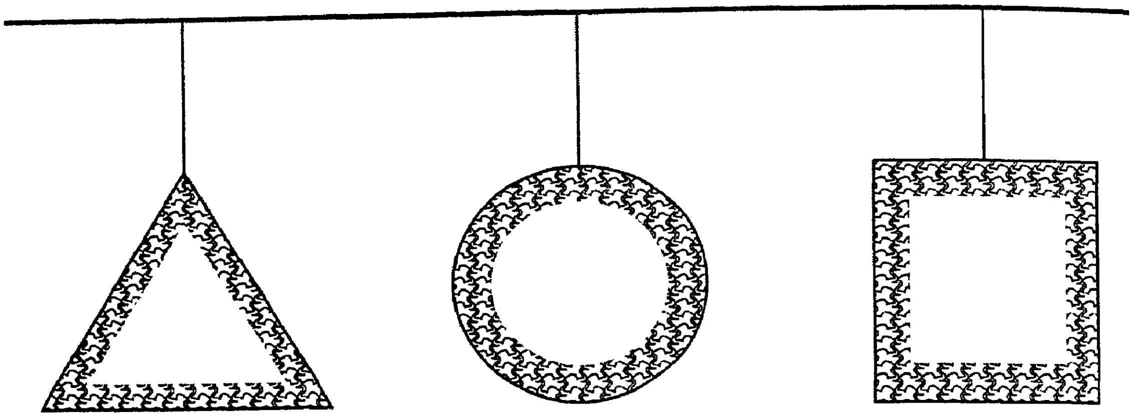


Figure 4.1 Functional / space absorbers for noise absorption

The use of functional absorbers is a common practice adopted in industrial establishments (where wall area for surface acoustic treatments is lacking) to control the build up of noise level from localised sources.

6. The entrance doors to the engine halls should be heavy and these should be provided with self closing mechanism. These should be kept closed during normal operation of the plant. Similarly the glasses of most of the hall windows (of the Mirrlees Engines hall) are either broken or these are not closed properly. Single/double glazed windows should be provided in the hall to prevent easy escape of sound into the environment. All these require a proper ventilation system for the hall, for the safety of the machines and comfort of the operators. Forced air ventilation systems with sound traps and baffle attenuators at the inlet and outlet ducts should be provided in the hall.
7. If the doors are to be kept open for operational reasons then permanent barrier walls should be erected in front of the entrances to prevent direct escape of noise into the surroundings. This will provide a sound attenuation of 2-3 dB in the normal case.
8. Barrier walls should be erected along the boundary of the power station facing residential areas. This can take a composite construction as shown in Figure 4.2. The combined effect of earth bund, baffle wall, plantation (2-5 m depth) and dense shrubs will provide a sound attenuation of the order of 5-10 dB depending upon the dimension of the composite wall. If the existing area is insufficient for this purpose, additional land should be acquired by evicting the inhabitants by paying proper compensation.

In many situations buying back the affected property from the residents will be an economic proposition to long drawn legal battles or regular stoppage of engines.

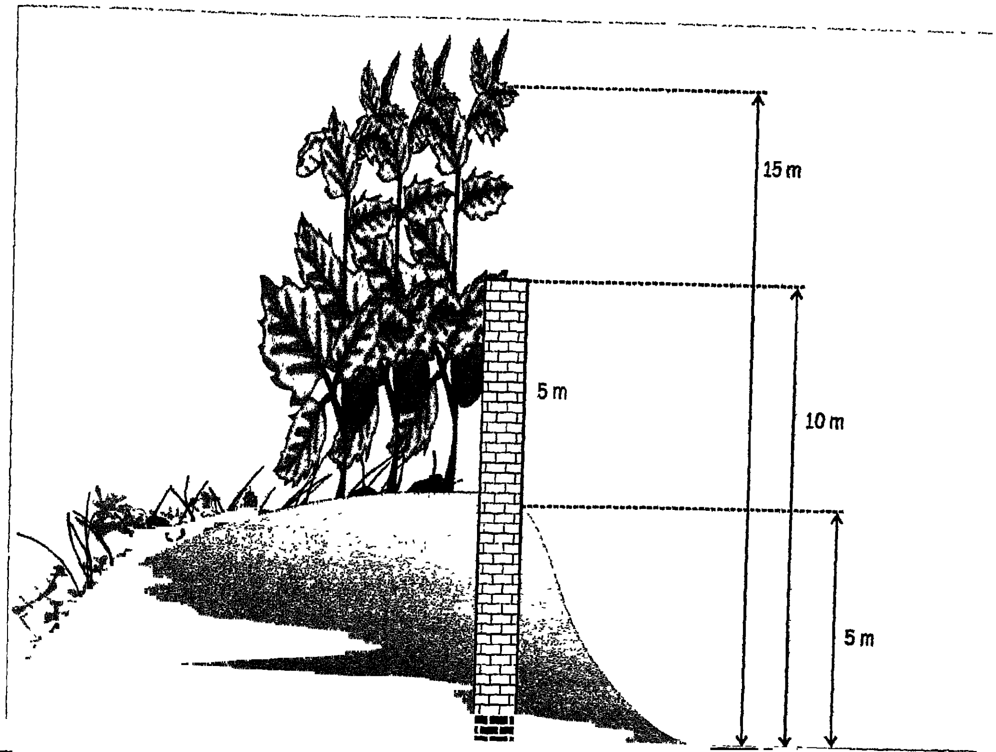


Figure 4.2 Composite barrier wall at the boundary of the power station

9. The sound insulation of the existing stacks should be improved by providing addition wrapping around them and silencers/mufflers in the path of the gas flow.
10. If all options are exhausted then the idea of providing financial assistance to the inhabitants towards improving the sound insulation of the dwelling units can be thought of as practised in some European countries. These measures include erecting proper noise barriers, redesign of the dwelling units, improving the insulation of windows and doors etc.

4.2.1 Economic aspects

The cost of any noise control project is directly related to the criterion selected as the goal for the end result. As the EPA requirement are very stringent, the noise control measures will push up the cost of the establishment by 30-50% of the present value. For example the provision of an acoustic hood for a simple portable generator set generally enhances the price of the set by a minimum of

30%. The approximate cost of the proposed noise control measures are given below which are based on estimates in India. The figures are given in Indian Rupees (Rs.) and US $ (assumed 1 US $ = 49 Rs.):

1. The cost of total machine enclosure will be Rs.15,000 (US $ 306) per sq. m. area for achieving a sound reduction of about 15 dB. The price of the forced air ventilation system will be about 25% of the total cost.
2. The partial enclosures will cost around Rs.5000 (US $ 102) per sq. m if the height of the barrier is that of the full enclosures.
3. The acoustic curtains will normally cost around Rs.2500 (US $ 51) per sq. m.
4. The acoustic treatment of the hall surfaces will cost around Rs.1000 (US $ 20) per sq. m.
5. The functional absorbers will cost around Rs.1500 (US $ 31) per piece for dimension around 1 m.
6. The double/single glazing of the windows will cost something of the order of Rs.10,000 / Rs. 5000 (US $ 204 / US $ 102) per window.
7. The barrier wall at the entrances to the hall will cost Rs. 3000 (US $ 61) per structure.
8. The composite wall along the periphery will cost about Rs.100 lakh per kilometre (US $ 204082 per kilometer).
9. The compensation to the dwelling units for improving sound insulation will vary between Rs.10,000 (US $ 204) to Rs.15,000 (US $ 306) per unit.

The proposed noise control measures could be implemented as a package depending upon the availability of funds and ease of implementation. It is hoped that the attenuations provided by the individual measures will help to achieve the overall goal of achieving the net sound reduction of 25 dB to meet the EPA requirement.

4.3 Vibration

For a systematic scientific study and cost estimates for modifications of both (old and new) power plants, the following work may be got done through the manufacturers of the engines, or institutes/consultants:

i) Measurement of vibrations (including FFT) length wise, width wise and height wise for the engines and generator, and the foundation blocks.
ii) Ground soil/rock investigations to establish its load bearing capacities in all three directions.

iii) Redesign the foundations for the permissible vibrations (depends on type of buildings/structures around the power plant, existing as well as likely to be constructed in future).
iv) Estimation of cost of putting the modified foundations (including the cost of dismantling the existing foundations and re-installation of all engines).
v) Estimate the power plant shut-down period required.

The organisation and the consultants who can possibly take up this work are:
i) The engines manufacturers/suppliers
ii) GERB Vibration Control Systems Pvt. Ltd.
3rd Floor, JOP Plaza, P-2, Sector 18,
Noida – 201 301 (UP), India
iii) Executive Director
Corporate R&D Division,
Bharat Heavy Electricals Ltd.
Vikas Nagar
Hyderabad-500093, India
iv) Head, Deptt. Of Earthquake Engineering
Indian Institute of Technology
Roorkee (UP), India
v) Head, Deptt. of Mechanical Engineering
Indian Institute of Technology
Kharagpur (WB), India
vi) Dr. K.G. Bhatia & Associates
(Consultants for Earthquake Engineering)
C-2/155, West Enclave
Pitampura,
New Delhi-110034, India

The above exercise will give a clear indication to CEB regarding the costs involved for the modifications.

4.4 Specific fuel consumption

In view of the high cost of power generation from diesel generators and the pollution/noise problems at the station, it is understood that this power plant will be run mainly on semi-base load or to meet the peak load power demand of the grid. Further the fuel efficiency of MAN engines is higher than that of Mirrlees engines. It is thus suggested that

i) MAN engines should be run on first priority. The running load of individual engines should be between 85% to 100%

ii) The switching on of these engines, synchronising and operation should be in series and not in parallel. This means that first one engine should be switched on and synchronised, and then brought to its maximum load. If there is further load demand, then second engine should be switched on and synchronised.

As the load requirement further increases, Mirrlees engines should be switched on one by one, and efforts should be made to run each one of these in the load range of 85 to 100%.

Environmental impact assessment
Air quality
Noise pollution
Victoria power station
Ground vibrations
Health effects

5

Conclusions

The Central Electricity Board plans to run Mirrlees engines as peak load from 2003, while MAN engines will continue to run on a semi-base load basis. On the basis of the current environmental study of the Fort Victoria power station, the following conclusions are drawn:

- The plant while in operation currently is able to meet the emission standards and also the ambient air quality standards as prescribed by the Government of Mauritius. Only in the case of nitrogen dioxide, the stack emissions are slightly above the prescribed EPA standards (but less than the WB guidelines). However, the ambient nitrogen dioxide concentrations are still well within the ambient air quality standards.
- A monitoring network of air quality stations in the vicinity of the power station has been suggested to regularly monitor air quality, especially during the months of April, May, November and December. This would help the authorities to exactly know the incidents of non-compliance of ambient air standards, if any, and may also act as a confidence building measure with the residents.
- As per the current operating conditions, the noise levels at the boundary of the power plant are higher than the prescribed standards for day and evening hours. Therefore, mitigation measures for reduction in noise levels inside as well as outside the engine house are important. The study suggests a list of measures that could be taken and the costs for the same. With the implementation of the control measures, if the plant can meet the noise levels standards at the boundary, MAN engines can continue to run in the night hours also.
- For tackling the vibration problem, a detailed scientific study is recommended that would include actual monitoring of the vibrations, the modifications required in the power plant along with the cost estimates.
- There is scope for improving the engine performance through simple measures as suggested in the report, such as running the individual engines above 85% load. This would help in reducing the fuel consumption and resultant savings in costs.

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Annexures

Annexure 1.1

MINISTRY OF ENVIRONMENT

DEPARTMENT OF THE ENVIRONMENT

ENFORCEMENT NOTICE

(Reference number: COM 1/139)

In pursuance of Section 58 of the Environment Protection Act 1991, I hereby notify you that:-

(1) I am of the opinion that you, The General Manager, Central Electricity Board of Royal Road Curepipe have contravened environmental laws as follows:

(a) Environmental laws contravened: -Environmental Standards for Noise Regulations 1997
- Environmental Standards for Air Regulations 1997

(b) Matters constituting the contravention :

(i) Noise and vibration pollution from different sections of your Power Station at Fort Victoria

(ii) Air pollution caused by NO_x and SO_2 emissions from the chimney stack of Fort Victoria Power Station

(2) Please note that a programme notice was already issued to you on 30th Jan 2001.

(3) You are accordingly requested to take the following measures **with immediate effect** to abate the nuisances:

(a) Operation of the MAN and Mirrlees engines be restricted to 7:00 AM and 9:00 PM

(b) The openings of the MAN engine house be kept closed to reduce noise

(4) You are also requested to take the following measures to abate the nuisances:

(a) Undertake a study to determine the nature and extent of nuisances caused by the Fort Victoria Power Station to the environment and to the nearby inhabitants, in particular air, noise and vibration pollution

(b) Find measures to avoid, prevent or to mitigate the negative impacts found in (a)

(c) Implement measures stated in (b)

Received from
M-E · 29·01·12

(d) Ensure that the measures taken in (b) are effective and that the nuisances are reduced to a satisfactory level

You are requested to implement those measures within 180 days of receipt of this notice.

WARNING

If you fail to comply with the requirements of this notice, you will commit an offence and may be liable:

(a) on a first conviction to a fine not less than Rs10,000 and not more than Rs 25,000 and to imprisonment for a term not exceeding 6 years

(b) On a second or subsequent conviction to a fine which shall be not less than Rs50, 000 and not more than Rs 250,000 and to imprisonment for a term which shall be not less than 6 years and not more than 12 years.

Signed:...............................

(Director of the Environment)

Date: ......5/01/2002......

Copy: Town Clerk, Municipal Council of Port Louis
Commissioner of Police
Permanent Secretary, Ministry of Public Utilities
Officer in Charge, Fort Victoria Power Station

Annexure 2.1

CENTRAL ELECTRICITY BOARD
FORT VICTORIA POWER STATION
OPERATION REPORT FOR MAN-B&W ENGINES MONTH DECEMBER1998

	ENG 11 1110019	ENG 12 1110020	MONTHLY TOTAL	YEARLY TOTAL
Date commissioned	Nov-89	Nov-89		
ENGINE HOURS				
Running Hrs	584	517	1101	10238
Stand-by Hrs	133	127	260	3038
Sch Maintenance	25	52	77	3438
Unsch Outages	2	48	50	806
Total	744	744	1488	17520
Total Hrs run since Jan	5197	5041		
Total Hrs run since comm.	51806	52033		
PRODUCTION				
KWH Generated	4327700	4048900	8376600	80168900
KWH used on works			272816	2722423
KWH Exported			8103784	77446477
KWH gen. since Jan	40674200	39494700		
GWH gen. since comm.	404 53	404 49		
FUEL				
Vol Light Fuel (m^3)			46 677	490 333
Vol Heavy Fuel (m^3)			1722 503	16447 079
Total Volume (m^3)			1769.18	16937 412
KWH gen /m^3 of Fuel			4734 74	4733 24
Mass Fuel (g)/KWH gen			200 00	200 00
Thermal Efficiency			44.11%	44 10%
Vol Light Fuel to Boilers			36 458	430 973
Total Volume Fuel (m^3)			1805.638	17368 385
Mass Fuel (g)/KWH Expo			210 48	211.67
Station Overall Efficiency			41.88%	41 63%
LUBRICATING OIL				
Lub Oil Used.	F	F		
Vol of Oil topped up (m^3)	10 536	9.328	19.864	
Vol of Oil changed (m^3)	0	0	0	
Total Oil Used	10 536	9.328	19 864	
Consump. of Oil (lt/hr)	18 04	18.04		
Consump. of Oil (g/kwh)	2.24	2.12		
Topping up since Jan (m^3)	104 348	98.01		202.358
Vol changed since Jan	0	0		0
Total Vol. used since Jan	104 348	98.01		202 358
CWA water consumption			67	1513
STOP. OF >5 DAYS				
Brief description				
Date out of Service				
Date returned into operation				
Percentage used :-	3.26%			

- Shell Argina X40

Light Fuel Sp gravity 0 844
Heavy Fuel Sp gravity 0.96

Caloric value = 42567 KJ/KG
Net Calorific Valu 40767 KJ/KG

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CENTRAL ELECTRICITY BOARD

FORT VICTORIA POWER STATION

OPERATION REPORT FOR MAN-B&W ENGINES MONTH:DECEMBER1999

	ENG 11 1110019	ENG 12 1110020	MONTHLY TOTAL	YEARLY TOTAL
Date commissioned	Nov-89	Nov-89		
ENGINE HOURS				
Running Hrs	673	662	1335	12663
Stand-by Hrs	37	60	97	2798
Sch.Maintenance	11	22	33	1380
Unsch. Outages	23	0	23	679
Total	744	744	1488	17520
Total Hrs run since Jan	6405	6258		
Total Hrs run since comm.	58211	58291		
PRODUCTION				
KWH Generated	5550000	5295200	10845200	99739400
KWH used on works			371610	3693151
KWH Exported			10473590	96046249
KWH gen. since Jan	50279200	49460200 ~~4.9E+07~~		
GWH gen. since comm.	454.81	453.95		
FUEL				
Vol. Light Fuel (m^3)			15.787	413.879
Vol. Heavy Fuel (m^3)			2269.307	20664.367
Total Volume (m^3)			2285.094	21078.246
KWH gen. /m^3 of Fuel			4746.08	4731.86
Mass Fuel (g)/KWH gen.			200.00	200.29
Thermal Efficiency			44.14%	44.06%
Vol. Light Fuel to Boilers			58.3	536.144
Total Volume Fuel (m^3)			2343.394	21614.39
Mass Fuel (g)/KWH Expo.			211.74	212.64
Station Overall Efficiency			41.65%	41.46%
LUBRICATING OIL				
ub . Oil Used.	F	F		
Vol. of Oil topped up (m^3)	14.121	13.891	28.012	
Vol. of Oil changed (m^3)	0	0	0	
Total Oil Used	14.121	13.891	28.012	
Consump. of Oil (lt/hr)	20.98	20.98		
Consump. of Oil (g/kwh)	2.34	2.42		
Topping up since Jan (m^3)	133.082	130.63		263.712
Vol.changed since Jan	0	0		0
Total Vol. used since Jan.	133.082	130.63		263.712
CWA water consumption			161	730
STOP. OF >5 DAYS				
Brief description				
Date out of Service				
Date returned into operation				
Percentage used :-	3.43%			

:- Shell Argina X40

Light Fuel Sp.gravity 0.844
Heavy Fuel Sp.gravity 0.96

Caloric value = 42567 KJ/KG
Net Calorific Valu 40767 KJ/KG

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CENTRAL ELECTRICITY BOARD

FORT VICTORIA POWER STATION

OPERATION REPORT FOR MAN-B&W ENGINES MONTH DECEMBER2000

	ENG 11 1110019	ENG 12 1110020	MONTHLY TOTAL	YEARLY TOTAL
Date commissioned	Nov-89	Nov-89		
ENGINE HOURS				
Running Hrs	524	191	715	8071
Stand-by Hrs	185	106	291	3033
Sch Maintenance	4	0	4	5233
Unsch Outages	31	447	478	1231
Total	744	744	1488	17568
Total Hrs run since Jan	4809	3262		
Total Hrs run since comm.	63020	61553		
PRODUCTION				
KWH Generated	5060100	1381100	6441200	64354100
KWH used on works			225140	2756563
KWH Exported			6216060	61597537
KWH gen. since Jan	38717200	25636900		
GWH gen. since comm.	493 53	479 59		
FUEL				
Vol Light Fuel (m)			13 206	365 475
Vol Heavy Fuel (m^3)			1378 33	13420 047
Total Volume (m^3)			1391.536	13785 522
KWH gen /m^3 of Fuel			4628 84	4668 24
Mass Fuel (g)/KWH gen			205 00	202 85
Thermal Efficiency			43.06%	43 49%
Vol Light Fuel to Boilers			34 625	352 289
Total Volume Fuel (m^3)			1426 161	14137 811
Mass Fuel (g)/KWH Expo			217 07	216 69
Station Overall Efficiency			40.63%	40 67%
LUBRICATING OIL				
Lub Oil Used	F	F		
Vol of Oil topped up (m^3)	3 24	1 181	4 421	
Vol of Oil changed (m^3)	0	0	0	
Total OiL Used	3 24	1 181	4 421	
Consump of Oil (lt/hr)	6 18	6 18		
Consump. of Oil (g/kwh)	0.59	0.79		
Topping up since Jan (m^3)	85 625	47 012		132 637
Vol changed since Jan	0	15 5		15 5
Total Vol used since Jan	85 625	62 512		148 137
CWA water consumption			540	4775
STOP. OF >5 DAYS				
Brief description		Fuel Cam Failure		
Date out of Service		17/11/00		
Date returned into operation		18/12/00		
Percentage used :-	3.50%			

- Shell Argina X40

Light Fuel Sp gravity 0.844
Heavy Fuel Sp gravity 0 96

Caloric value = 42567 KJ/KG
Net Calorific Valu 40767 KJ/KG

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CENTRAL ELECTRICITY BOARD

FORT VICTORIA POWER STATION

OPERATION REPORT FOR MAN-B&W ENGINES MONTH D

Date commissioned	ENG 11 1110019 Nov-89	ENG 12 1110020 Nov-89	MONTHLY TOTAL
ENGINE HOURS			
Running Hrs	427	386	813
Stand-by Hrs	254	260	514
Sch Maintenance	17	76	93
Unsch Outages	46	22	68
Total	744	744	1488
Total Hrs run since Jan	4511	3591	
Total Hrs run since comm	67531	65144	
PRODUCTION			
KWH Generated	3149600	2806100	5955700
KWH used on works			289977
KWH Exported			5665723
KWH gen. since Jan	35845000	26820100	
GWH gen. since comm	529 38	506 41	
FUEL			
Vol Light Fuel (m^3)			41 087
Vol Heavy Fuel (m^3)			1217 754
Total Volume (m^3)			1258.841
KWH gen /m^3 of Fuel			4731 10
Mass Fuel (g)/KWH gen			200 00
Thermal Efficiency			44.10%
Vol Light Fuel to Boilers			32 016
Total Volume Fuel (m^3)			1290.857
Mass Fuel (g)/KWH Expo			214 95
Station Overall Efficiency			40.99%
LUBRICATING OIL			
ub Oil Used	F	F	
Vol of Oil topped up (m^3)	4 617	4 174	8 791
Vol of Oil changed (m^3)	0	0	0
Tota L Used	4 617	4 174	8 791
Consump of Oil (lt/hr)	10 81	10 81	
Consump. of Oil (g/kwh)	1.35	1.37	
Topping up since Jan (m^3)	31 204	25 926	
Vol changed since Jan	0	0	
otal Vol used since Jan	31 204	25 926	
CWA water consumption			286
STOP. OF >5 DAYS			
Brief description			
Date out of Service			
Date returned into operation			
Percentage used	4.87%		

- Shell Argina X40

Light Fuel Sp gravity = 0 844
Heavy Fuel Sp gravity = 0.96

Caloric value = 42567 KJ/KG
Net Calorific Valu 40767 KJ/KG

OPERATION REPORT FOR MIRRLEES ENGINES & STAND-BY SETS

Annx – 2·1)5 MONTH DECEMBER 1998

Date commissioned	ENG 3 6586/1 28 06 75	ENG 5 6524/2 03 02 74	6 [illegible]/1 28 02 78	ENG 7 6640/2 27 07 76	ENG 8 6586/2 23 03 75	ENG 9 6698/1 07 07 77	EN 6698/2 13 09 77	HOUSE SET NO 1	HOUSE SET NO 2	MONTHLY TOTAL	YEARLY TOTAL
ENGINE HOURS											
Running Hrs	266	38	308	243	360	299	364	4	24	1906	21371
Stand-by Hrs	436	175	394	497	352	399	344	740	720	4057	45217 5
Sch Maintenance	29	181	10	0	25	26	23	0	0	294	4660
Unsch Outages	13	350	32	4	7	20	13	0	0	439	7591 5
Total	744	744	744	744	744	744	744	744	744	6696	78840
Total Hrs run since Jan	2942	1517	3284	2686	2784	3776	3980	189	213		
Total Hrs run since comm.	59238	67893	53740	46205	57159	57860	58217	0	0		
PRODUCTION											
KWH Generated	933500	119600	1104200	706000	1141200	989600	1356300	370	2240	6353010	74786080
KWH used on works										263360	2894856
KWH Exported										6089650	71891224
KWH gen. since Jan	10638200	4253400	11586300	9192100	10393700	13538500	15143800	18590	21490		
GWH gen since comm.	244 63	294 97	214 42	195 70	248 71	234 84	229 58	0 01	0 02		
FUEL											
Vol Light Fuel (m³)										128 816	1101 557
Vol Heavy Fuel (m³)										1561 948	18751 95
Total Volume (m³)										1690 762	19853 51
KWH gen /m³ of Fuel										3757 48	3766 90
Mass Fuel (g)/KWH gen										250 47	250 49
Thermal Efficiency										35 15%	35 18%
Vol Light Fuel to Boilers										25 87	299 573
Total Volume Fuel (m³)										1716 432	20117 43
Mass Fuel (g)/KWH Expo										264 82	264 05
Station Overall Efficiency										33 23%	33 35%
LUBRICATING OIL											
Lub Oil Used	D	D	D	D	D	D	D	C	C		
Vol of Oil topped up (m³)	4 623	0 84	4 872	3 346	5 646	3 551	6 064	0	0	28 942	
Vol of Oil changed (m³)	0	3 003	0	0	0	0	0	0	0	3 003	
Total OiL Used	4 623	3 843	4 872	3 346	5 646	3 551	6 064	0	0	31 945	
Consump of Oil (lt/hr)	17 38	101 13	15 82	13 77	15 68	11 88	16 66	0 00	0 00		
Consump. of Oil (g/kwh)	4 46	6.32	3.97	4 27	4 45	3 23	4 02	0 00	0 00		
Topping up since Jan (m³)	46 406	21 236	51 872	50 746	51 091	41 922	64 835	0	0		328 108
Vol changed since Jan	2 61	5 403	0	0	3 425	0	0	0	0		11 438
Total Vol used since Jan	49 016	26 839	51 872	50 746	54 516	41 922	64 835	0	0		339 546
CWA water consumption										1287	17965
STOP OF >5 DAYS											
Brief description		Main Bearing Damaged									
Date out of Service		12/06/1998									
Date returned into operation		21/12/1998									
Percentage used :-	4 15%										

C - Caltex R P M Delo 3000
Marine SAE 30
D - Esso Exxmar 30 TP 30

Light Fuel Sp gravity =	0 844	Caloric value :	42567 KJ/KG
Heavy Fuel Sp gravity =	0 96	Net Calorific Val	40767 KJ/KG
Lub Oil Sp gravity =	0 9		

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FORT VICTORIA POWER STATION

OPERATION REPORT FOR MIRRLEES ENGINES & STAND-BY SETS

MONTH DECEMBER 1999

	ENG 3 6586/1	ENG 5 6524/2	ENG 6 6640/1	ENG 7 6640/2	ENG 8 6586/2	ENG 9 6698/1	ENG 10 6698/2	HOUSE SET NO 1	HOUSE SET NO 2	MONTHLY TOTAL	YEARLY TOTAL
Date commissioned	26 08 75	03 02 74	26 02 76	27 07 76	23 03 75	07 07 77	13 09 77				
ENGINE HOURS											
Running Hrs	294	307	215	331	0	295	0	0	1	1443	20314
Stand-by Hrs	436	403	263	399	0	402	0	744	743	3390	40511
Sch Maintenance	11	7	203	0	0	15	0	0	0	236	8701
Unsch Outages	3	27	63	14	744	32	744	0	0	1627	9314
Total	744	744	744	744	744	744	744	744	744	6696	78840
Total Hrs run since Jan	2818	4019	3047	2879	2890	3326	1361	86	86		
Total Hrs run since comm.	61854	71912	56787	49084	60049	61188	59578	0	0		
PRODUCTION											
KWH Generated	922500	1005200	789400	1090000	0	1053900	C	0	110	486111C	70297310
KWH used on works										113952	2214010
KWH Exported										4747158	68083300
KWH gen. since Jan	8398800	13561400	10584200	10353400	9813200	1267180C	4900300	688C	7330		
GWH gen. since comm.	253 03	308 53	225 00	206 06	258 53	247 51	234 48	0 01	0 01		
FUEL											
Vol Light Fuel (m^3)										44 399	947 208
Vol Heavy Fuel (m^3)										1353 221	18153 97
Total Volume (m^3)										1397 62	19101 17
KWH gen /m^3 of Fuel										3478 13	3680 26
Mass Fuel (g)/KWH gen										272 08	256 57
Thermal Efficiency										32 42%	34 35%
Vol Light Fuel to Boilers										20 1	272 563
Total Volume Fuel (m^3)										1417 72	19373 74
Mass Fuel (g)/KWH Expo										282 14	268 25
Station Overall Efficiency										31 24%	32 84%
LUBRICATING OIL											
Lub Oil Used	D	D	D	D	D	D	D	C	C		
Vol. of Oil topped up (m^3)	4 911	2 94	1 911	4 6	0	4 337	0	0	0	18 699	
Vol of Oil changed (m^3)	0	0	3 115	0	0	0	0	0	0	3 115	
Total OiL Used	4 911	2 94	5 026	4 6	0	4 337	0	0	0	21 814	
Consump of Oil (lt/hr)	16 70	9 58	23 38	13 90	0 00	14 70	0 00	0 00	0 00		
Consump. of Oil (g/kwh)	4.79	2 63	2.18	3 80	0.00	3.70	0.00	0 00	0 00		
Topping up since Jan (m^3)	41 447	44 65	49 095	44 916	47 671	43 836	18 647	0	0	290 262	
Vol changed since Jan	1 059	0 84	3 115	2 509	0 922	3 137	0	0	0	11 582	
Total Vol used since Jan	42 508	45 49	52 21	47 425	48 593	46 973	18 647	0	0	301 844	
CWA water consumption										778	12409
STOP. OF >5 DAYS											
Brief description			6000 Hrs Maintenance		High level of Pb Eng Shutdown		Bearing Failure				
Date out of Service			20/09/1999		25/09/1999		17/05/1999				
Date returned into operation			09/12/1999								
Percentage used :-	2.34%										

C - Caltex R P M Delo 3000
Marine SAE 30
D -Esso Exxmar 30 TP 30

Light Fuel Sp gravity =	0 844	Caloric value :	42567 KJ/KG
Heavy Fuel Sp gravity =	0 96	Net Calorific Vali	40767 KJ/KG
Lub Oil Sp gravity =	0 9		

CENTRAL ELECTRICITY BOARD

FORT VICTORIA POWER STATION

OPERATION REPORT FOR MIRRLEES ENGINES & STAND-BY SETS

MONTH -DECEMBER 2000

	ENG 3 6586/1	ENG 5 6524/2	ENG 6 6640/1	ENG 7 6640/2	ENG 8 6586/2	ENG 9 6698/1	ENG 10 6698/2	HOUSE SET NO 1	HOUSE SET NO 2	MONTHLY TOTAL	YEARLY TOTAL
Date commissioned	28 06 75	03 02 74	26 02 76	27 07 76	23 03 75	07 07 77	13 09 77				
ENGINE HOURS											
Running Hrs	124	59	118	137	0	155	154	2	2	751	10852
Stand-by Hrs	810	215	593	540	0	553	530	742	742	4525	46307
Sch Maintenance	0	0	0	0	744	0	0	0	0	744	10168
Unsch Outages	10	470	33	67	0	36	60	0	0	676	11729
Total	744	744	744	744	744	744	744	744	744	6696	79056
Total Hrs run since Jan	2090	1326	2169	2311	0	2253	670	16	17		
Total Hrs run since comm.	63944	73238	58956	51395	60049	63441	60248	0	0		
PRODUCTION											
KWH Generated	402400	184400	411500	477400	0	586300	587600	80	60	2649740	34923720
KWH used on works										138371	1391708
KWH Exported										2513388	33532012
KWH gen. since Jan	5956000	4723100	7415200	7104300	0	7373700	2349900	710	810		
GWH gen. since comm.	258 99	313 25	232 42	213 16	256 53	254 88	236 83	0 00	0 00		
FUEL											
Vol Light Fuel (m³)										58 722	650 836
Vol Heavy Fuel (m³)										673 584	9291 192
Total Volume (m³)										732 306	9942 028
KWH gen /m³ of Fuel										3618 35	3512 74
Mass Fuel (g)/KWH gen										259 98	268 28
Thermal Efficiency										33 86%	32 83%
Vol Light Fuel to Boilers										10 956	144 406
Total Volume Fuel (m³)										743 262	11264 53
Mass Fuel (g)/KWH Expo										277 72	283 01
Station Overall Efficiency										31 68%	31 11%
LUBRICATING OIL											
Lub Oil Used	D	D	D	D	D	D	D	C	C		
Vol of Oil topped up (m³)	2 73	1 47	2 16	3 355	0	3 346	3 137	0	0	16 198	
Vol of Oil changed (m³)	0	4 061	0	0	0	0	0	0	0	4 061	
Total OiL Used	2 73	5 531	2 16	3 355	0	3 346	3 137	0	0	20 259	
Consump of Oil (lt/hr)	22 02	93 75	18 31	24 49	0 00	21 59	20 37	0 00	0 00		
Consump. of Oil (g/kwh)	6 11	7 17	4 72	6 32	0 00	5 14	4 80	0 00	0 00		
Topping up since Jan (m³)	47 246	36 553	30 814	56 888	0	45 647	15 64	0	0		232 788
Vol changed since Jan	0	4 061	0 896	0	0	0 889	0 932	0	0		6 778
Total Vol used since Jan	47 246	40 614	31 71	56 888	0	46 536	16 572	0	0		239 566
CWA water consumption										1312	10875
STOP. OF >5 DAYS											
Brief description		B End Bearing Failure			6000 Hrs Maintenance						
Date out of Service		28/07/2000			01/08/2000						
Date returned into operation		19/12/2000									
Percentage used	5 15%										

P.M Delo 3000
SAE 30
~~xmar 30 TP 30~~
Mpi, T 36

Light Fuel Sp gravity =	0 844		Calonc value :	42567 KJ/KG
Heavy Fuel Sp gravity =	0 96		Net Calorific Vali	40767 KJ/KG
Lub Oil Sp gravity =	0 9			

CENTRAL ELECTRICITY BOARD

FORT VICTORIA POWER STATION

OPERATION REPORT FOR MIRRLEES ENGINES & STAND-BY SETS

MONTH DECEMBER 2001

	ENG 3 6586/1	ENG 5 6524/2	ENG 6 6640/1	ENG 7 6640/2	ENG 8 6586/2	ENG 9 6698/1	ENG 10 6696/2	HOUSE SET NO 1	HOUSE SET NO 2	MONTHLY TOTAL	YEARLY TOTAL
Date commissioned	26 06 75	03 02 74	26 02 76	27 07 76	23 03 75	07 07 77	13 09 77				
ENGINE HOURS											
Running Hrs	10	0	70	88	132	129	90	2	1	522	5613
Stand-by Hrs	200	0	626	650	608	592	616	742	743	4777	61003
Sch Maintenance	0	744	0	0	0	0	0	0	0	744	8331
Unsch Outages	534	0	48	6	4	23	38	0	0	653	3893
Total	744	744	744	744	744	744	744	744	744	6696	78840
Total Hrs run since Jan	698	572	820	898	731	693	1060	19	21		
Total Hrs run since comm	64643	73810	59876	52293	50780	64134	61308	0	0		
PRODUCTION											
KWH Generated	28100	0	237300	297800	361400	474100	311300	130	60	1709960	17818520
KWH used on works										73853	1083375
KWH Exported										1636107	16735145
KWH gen since Jan	2132700	1814000	3194000	3043400	1743500	2341100	3546800	1250	1670		
GWH gen. since comm.	281 12	315 06	235 61	216 20	260 27	257 22	240 38	0 00	0 00		
FUEL											
Vol Light Fuel (m^3)										49 885	601 213
Vol Heavy Fuel (m^3)										377 553	4607 912
Total Volume (m^3)										427 438	5209 125
KWH gen /m^3 of Fuel										4000 49	3420 64
Mass Fuel (g)/KWH gen										234 08	273 81
Thermal Efficiency										37 55%	32 11%
Vol Light Fuel to Boilers										7 067	73 669
Total Volume Fuel (m^3)										434 505	5282 793
Mass Fuel (g)/KWH Expo										248 29	295 20
Station Overall Efficiency										35 39%	29 76%
LUBRICATING OIL											
Lub Oil Used	C	C	C	C	C	C	C	C	C		
Vol of Oil topped up (m^3)	0 63	0	1 105	2 432	2 436	1 548	2 432	0	0	10 583	
Vol of Oil changed (m^3)	0	0	0	0	0	0	0	0	0	0	
Total OIL Used	0 83	0	1 105	2 432	2 436	1 548	2 432	0	0	10 583	
Consump of Oil (lt/hr)	63 00	0 00	15 79	27 64	16 45	12 00	27 02	0 00	0 00		
Consump. of Oil (g/kwh)	20 18	0 00	4 19	7 35	6 07	2 94	7 03	0 00	0 00		
Topping up since Jan (m^3)	16 298	15 099	15 588	22 168	12 258	12 088	25 657	0	0		119 156
Vol changed since Jan	1 69	0	0	0	2 509	2 318	0	0	0		6 517
Total Vol used since Jan	17 988	15 099	15 588	22 168	14 767	14 406	25 657	0	0		125 673
CWA water consumption										519	14735
STOP OF >5 DAYS		6000 Hrs									
Brief description		Maintenance									
Date out of Service		29/10/2001									
Date returned into operation											
Percentage used	4 32%										

C - Shell Argina T 30

Light Fuel Sp gravity =	0 844	Calorific value	42567 KJ/KG
Heavy Fuel Sp gravity =	0 96	Net Calorific Val	42767 KJ/KG
Lub Oil Sp gravity =	0 9		

CENTRAL ELECTRICITY BOARD

FORT VICTORIA POWER STATION

Major breakdowns during year 2000 & 2001

ENGINES	BREAKDOWN
NO.3	Changed piston A5 as piston outlet temperature was abnormally low 07/07/00-01/08/00 Low lub oil pressure tripping. Checking of alignment. cleaned oil ,water valvecage coolers and air filters. Changed exhaust valve on Cyl A3 and turbochargers.
NO.5	15/01/00-01/03/00 Camshaft failure. 30/05/00-23/06/00 Big end bearing failure.
NO.6	10/04/00-21/04/00 Cam failure B8. 03/07/00-13/07/00 Changed Cylinder head A4. Removed piston. Changed Push rod, rocker arm on inlet as high Exhaust temperature was noted on A4. 12/11/00-17/11/00 Engine failed to start. Dismantle of control valve jacket water outlet. Dismantle of 4 – way valve and changed thermometer on heavy fuel circuit. Change thermometer on outlet jacket water and light fuel filter.
NO.7	04/01/01-09/01/01 Foot Valve A5 damaged.
NO.8	High level of lead content in lubricating oil . Engine shutdown as from 24/09/99. Maintenance as from 01/08/00 up to 18/04/2001
NO.10	Main bearing failure on 17/05/99 Grinding and line boring (complete rehabilitation). Engine in operation on 15/06/00
NO.11	12/06/01-19/06/01 Exhaust cam failure of Cylinder no.1.
NO.12	17/11/00-18/12/00 Fuel cam failure of Cylinder no. 3 . 19/02/01-23/02/01 High lubricating oil temperature. Dismantle and acid cleaning of plate coolers.

CENTRAL ELECTRICITY BOARD

FORT VICTORIA POWER STATION

OPERATION REPORT FOR MIRRLEES ENGINES & STAND-BY SETS

MONTH DECEMBER 2001

	ENG 3	ENG 5	ENG 6	ENG 7	ENG 8	ENG 9	ENG 10	HOUSE SET NO 1	HOUSE SET NO 2	MONTHLY TOTAL	YEARLY TOTAL
	6586/1	6524/2	6640/1	6640/2	6586/2	6698/1	6696/2				
Date commissioned	26 06 75	03 02 74	26 02 76	27 07 76	23 03 75	07 07 77	13 09 77				
ENGINE HOURS											
Running Hrs	10	0	70	88	132	129	90	2	1	522	5613
Stand-by Hrs	200	0	626	650	608	592	616	742	743	4777	61003
Sch Maintenance	0	744	0	0	0	0	0	0	0	744	8331
Unsch Outages	534	0	48	6	4	23	38	0	0	653	3893
Total	744	744	744	744	744	744	744	744	744	6696	78840
Total Hrs run since Jan	699	572	920	898	731	693	1060	19	21		
Total Hrs run since comm	64643	73810	59876	52293	60780	64134	61308	0	0		
PRODUCTION											
KWH Generated	28100	0	237300	297600	361400	474100	311300	130	60	1709960	17818520
KWH used on works										73853	1083375
KWH Exported										1636107	16735145
KWH gen since Jan	2132700	1814000	3194000	3043400	1743500	2341100	3546800	1250	1670		
GWH gen since comm	261 12	315 06	235 61	216 20	260 27	257 22	240 38	0 00	0 00		
FUEL											
Vol Light Fuel (m³)										49 885	601 213
Vol Heavy Fuel (m³)										377 553	4607 912
Total Volume (m³)										427 438	5209 125
KWH gen /m³ of Fuel										4000 49	3420 64
Mass Fuel (g)/KWH gen										234 08	273 81
Thermal Efficiency										37 55%	32 11%
Vol Light Fuel to Boilers										7 067	73 668
Total Volume Fuel (m³)										434 505	5282 793
Mass Fuel (g)/KWH Expo										246 2[illegible]	295 20
Station Overall Efficiency										35 39%	29 76%
LUBRICATING OIL											
Lub Oil Used	C	C	C	C	C	C	C	C	C		
Vol of Oil topped up (m³)	0 63	0	1 105	2 432	2 436	1 546	2 432	0	0	10 581	
Vol of Oil changed (m³)	0	0	0	0	0	0	0	0	0	0	
Total OiL Used	0 63	0	1 105	2 432	2 436	1 548	2 432	0	0	10 581	
Consump of Oil (lt/hr)	63 00	0 00	15 79	27 64	16 45	12 00	27 02	0 00	0 00		
Consump. of Oil (g/kwh)	20 18	0 00	4 19	7 35	6 07	2 94	7 03	0 00	0 00		[illegible]
Topping up since Jan (m³)	16 298	15 099	15 588	22 168	12 258	12 088	25 657	0	0		119 156
Vol changed since Jan	1 69	0	0	0	2 509	2 318	0	0	0		6 517
Total Vol used since Jan	17 988	15 099	15 588	22 168	14 767	14 406	25 657	0	0		125 673
CWA water consumption										519	14735
STOP OF >5 DAYS											
Brief description		6000 Hrs Maintenance									
Date out of Service		29/10/2001									
Date returned into operation											
Percentage used -	4 32%										

C - Shell Argina T 30

Light Fuel Sp gravity =	0 844	Caloric value	42557 KJ/KG
Heavy Fuel Sp gravity =	0 96	Net Calorific Vali	42767 KJ/KG
Lub Oil Sp gravity =	0 9		

CENTRAL ELECTRICITY BOARD
FORT VICTORIA POWER STATION

Major breakdowns during year 2000 & 2001

ENGINES	BREAKDOWN
NO.3	Changed piston A5 as piston outlet temperature was abnormally low 07/07/00-01/08/00 Low lub oil pressure tripping. Checking of alignment. cleaned oil ,water valvecage coolers and air filters. Changed exhaust valve on Cyl A3 and turbochargers.
NO.5	15/01/00-01/03/00 Camshaft failure. 30/05/00-23/06/00 Big end bearing failure.
NO.6	10/04/00-21/04/00 Cam failure B8. 03/07/00-13/07/00 Changed Cylinder head A4. Removed piston. Changed Push rod, rocker arm on inlet as high Exhaust temperature was noted on A4. 12/11/00-17/11/00 Engine failed to start. Dismantle of control valve jacket water outlet. Dismantle of 4 – way valve and changed thermometer on heavy fuel circuit. Change thermometer on outlet jacket water and light fuel filter.
NO.7	04/01/01-09/01/01 Foot Valve A5 damaged.
NO.8	High level of lead content in lubricating oil . Engine shutdown as from 24/09/99. Maintenance as from 01/08/00 up to 18/04/2001
NO.10	Main bearing failure on 17/05/99 Grinding and line boring (complete rehabilitation). Engine in operation on 15/06/00
NO.11	12/06/01-19/06/01 Exhaust cam failure of Cylinder no. 1.
NO.12	17/11/00-18/12/00 Fuel cam failure of Cylinder no. 3 . 19/02/01-23/02/01 High lubricating oil temperature. Dismantle and acid cleaning of plate coolers.

Test bed data for MAN engines

Annexure 2.2

```
100  %  Load   [illegible] AT SITE                              Blatt/Sheet    14
==============================================================================
.A.N           Operating  Results                    Meas.No.: 1.11
 & W                                                 Load    : 100% MCR-G
                                                     Date    : 28.05.98
                                                     Time    : 09:43
==============================================================================
Engine Type       :    8L58/64        Amb. Pressure      :   953.5   mbar
Engine No.        :    1110019        Rel.Air Humidity:      60      %
Testbed No.       :    33             Luboil Spez.       :   SHELLArgina40
Brake Type        :    FROUDE         Fuel Spez.         :   HF-177 cSt
Turbocharger      :    NA57 T702      Lever Pos.         :   0
Brake Const.      :    1              Lower Heat Value:      40050  kJ/kg
Turbocharger No.  :    [illegible]
------------------------------------------------------------------------------
Power
Engine Speed                          rpm     428.1
Water Brake Force                     t/kN     23.83
Engine Output                         kW    10202.
Mean eff.Pressure                     bar      21.14
------------------------------------------------------------------------------
Governor                                               1    2    3    4    5    6    7    8
Pump Admission                        mm             83.0 83.0 83.0 83.0 83.0 83.0 83.0 83.5
Pump Admission (Mean Value)           mm       83.1
 ad Indicator Governor                -         7.6
------------------------------------------------------------------------------
Fuel
Temperature                           °C      139.
Pressure before engine                bar       4.2
Quantity                              kg       64.2
Time                                  sec     120.0
Consumption                           kg/h   1927.0
S.F.C based on L.H.V                  g/kW    188.9
S.F.C based on 42707 kJ/kg            g/kW    177.1
------------------------------------------------------------------------------
Charging Air
Temperature before Blower             °C       22.3
Temperature after  Blower             °C      179.8
Temperature before Cylinder           °C       36.9
Pressure    before Cylinder           mbar   2381.
Diff.Pressure Intercooler             mbar     32.
------------------------------------------------------------------------------
Exhaust Gas                                             1    2    3    4    5    6    7    8
Temp. after Zyl.                      °C              409  426  420  432  432  419  430  426
Temp. after Zyl. (Mean Value)         °C      424.
Temperature before Turbine            °C      480.
Temperature after  Turbine            °C      331.
Pressure    before Turbine            mbar   1698.
Pressure    after  Turbine            mbar     23.←
 Turbocharger Speed                   rpm   13542.
------------------------------------------------------------------------------
Lubrication Oil                              before      after
Temperature Engine                    °C      60.7       69.4
Temperature TC                        °C      60.7       79.2
Pressure  Engine                      bar      4.0
Pressure TC                           bar      1.5
------------------------------------------------------------------------------
Cooling Water                                before      after
Temperature Eng.Jacket                °C      71.7       80.1
Temperature Nozzle                    °C      73.7       75.9
Temp. Intercool.                      °C      31.2       41.3
Temperature TC                        °C      71.7       74.5
Pressure Eng.Jacket                   bar      3.6
Pressure Nozzle                       bar      2.8
Pressure Intercool.2                  bar      3.2
------------------------------------------------------------------------------
Main Bearing  No.                              01  I   II  III  IV  V   VI  VII VIII IX  X
Temp. Main Bearing                    °C       79  82  86  86   88  87  86  86  87   84

Crankcase Pressure                    mbar      1.5
------------------------------------------------------------------------------
M.A.N          | Classification Societies    | Customer
               |                             |
               |                             |
------------------------------------------------------------------------------
All pressure values without ambient pressure !

     WATERINLET INTERCOOLER = 32 °C
Kühlwassertemp. Eintritt LLK = 32 °C
```

Test bed data for Mirrlees engines

Annexure 2.3

MAN B&W Diesel Ltd

MAN B&W

Mirrlees Blackstone

EXHAUST EMISSIONS RUNNING ON RESIDUAL (HEAVY) FUEL

Date: 14/03/02

STANDARD TIMED ENGINE BUILT FOR MAXIMUM THERMAL EFFICIENCY

Engine Details :-

Project or Cont.no.: 6698
Engine Type: KV16 Major Mk2
Engine Speed: 600 rpm

Fuel type / name : 180 Cst
Sulphur Content : 3.50 % MAX.

Rated capacity = 6600 KW.

	LOAD % 100	75	50	
Engine Power Output (Site) :	6872	5154	3436	bkW- generator η = kW.
Nett Calorific Value of Fuel :	42.7	42.7	42.7	MJ/kg
Specific Fuel Consumption : (+/-5% Tolerance)	205.0	205.0	210.0	g/bkW.h

Exhaust Gas Data

	100	75	50	
Specific exhaust gas mass flow :	7.30	7.65	8.60	kg/bkW.h
Temperature :	425	390	360	deg C
Oxygen content of exhaust :	13.90	14.20	14.40	%

	100	75	50	
Specific exhaust gas mass flow : (Corrected to 15% Oxygen)	8.64	8.67	9.46	kg/bkW.h

Oxides of Nitrogen - NOx (as NO2)

	100	75	50	
Measured NOx emission rate :	2500	2400	2300	mg/Nm3
	1218	1170	1121	ppm v/v
	14.91	15.00	16.16	g/bkW.h

	100	75	50	
Corrected to 15% Oxygen :	2113	2118	2091	mg/Nm3
	1030	1032	1019	ppm v/v
	12.60	13 24	14.69	g/bkW.h

Oxides of Sulphur - SOx (as SO2)

	100	75	50	
Sulphur content of Fuel :	3.50	3.50	3.50	%

	100	75	50	
Measured SOx emission rate :	2404	2294	2090	mg/Nm3
	841	802	731	ppm v/v
	14.34	14.34	14.69	g/bkW.h

	100	75	50	
Corrected to 15% Oxygen :	2031	2024	1900	mg/Nm3
	710	708	665	ppm v/v
	12.11	12.65	13.35	g/bkW.h

Carbon Monoxide - CO

Measured CO emission rate :	47	51	61	mg/Nm3
	38	41	49	ppm v/v
	0.28	0.32	0.43	g/bkW.h

Corrected to 15% Oxygen :	40	45	55	mg/Nm3
	32	36	44	ppm v/v
	0.24	0.28	0.39	g/bkW.h

Non Methane Hydrocarbons as C3H8 (Propane)

Measured emission rate :	443	503	513	mg/Nm3
	225	256	261	ppm v/v
	2.64	3.14	3.60	g/bkW.h

Corrected to 15% Oxygen :	374	444	466	mg/Nm3
	190	226	237	ppm v/v
	2.23	2.77	3.28	g/bkW.h

Particulates - Dry

Measured emission rate :	90	90	90	mg/Nm3
	0.54	0.56	0.63	g/bkW.h

Carbon Dioxide

Measured emission rate :	5.80	5.80	5.80	% vol

Corrected to 15% Oxygen :	4.90	5.12	5.27	% vol

Nitrogen - N2

Measured emission rate :	78.00	78.00	78.00	% vol

Water Vapour (H2O)

Measured emission rate :	3.50	3.50	3.50	% vol

NOTES :

Emission figures are based on fuel with a net calorific value of 42.7 MJ/kg and a maximum sulphur content of 3.50 %

All emission figures shown are estimated only based on as new engines. We have no specific measured data available for engines of this age and build.

Characteristics of fuel used

Annexure 2.4

Saybolt Laboratory Fujairah

CERTIFICATE OF QUALITY REF.No.283/00

Product: Fuel Oil 180 cSt
Source: 'Sea Rose' (7/03/00) Ships Composite (1,2,6C & 7p/s) after loading off Fujairah UAE.
Test Date: 7-8/03/00

TEST	UNIT	METHOD	RESULT
Density @ 15 deg C	Kg/L	ASTM D 4052	0.9566
Kin. Viscosity @ 50 deg C	cSt	ASTM D 445	174.5
Flash Point	Deg C	ASTM D [illegible]	76
Pour Point	Deg C	ASTM D 97	9
Ash	Mass %	ASTM D 482	0.02
Carbon Residue	Mass %	ASTM D 189	11.41
Water	Vol %	ASTM D 95	0.25
Sulphur	Mass %	ASTM D 4294	2.96
Vanadium	ppm wt	A.A.S.	95
Sodium	ppm wt	A.A.S.	10
Aluminium	ppm wt	IP 377	<5
Sediment	Mass %	ASTM D 473	0.02
Hot Filtration Test	Mass %	SMS 742	0.01
Calorific Value Gross	MJ/Kg	Calculated	42.94
Net			40.54
CCAI		Calculated	825
Stability :			
Existent Dry Sludge	Mass %	IP 375	0.01
Potential Dry Sludge	Mass %	IP 390A	0.01

Precision parameters apply to the determination of the test results specified above. Please also refer to ASTM D 3244/77 (83), IP – 367 and appendix "E" of IP standard methods for analysis and testing with respect to the utilisation of test data to determine conformance with the relevant ASTM or IP specifications".

This report is issued in accordance with the General Terms and Conditions of Saybolt Abu Dhabi and the recipient is deemed to have full knowledge thereof.

SAYBOLT
Petroleum Inspectors
P.O. Box : 4[illegible] Abu Dhabi - U.A.E.

to the Government Gazette of Mauritius No. 92 of 29 August 1998

Government Notice No. 105 of 1998

THE ENVIRONMENT PROTECTION ACT 1991

Regulations made by the Minister under Section 35 of the Environment Protection Act 1991

1. These regulations may be cited as the Environment Protection (Standards for Air) Regulations 1998.

2. In these regulations —

"Act" means the Environment Protection Act 1991;

"chimney" means a structure or opening from or through which a product of combustion or an air pollutant is emitted into the atmosphere;

"enforcing agency" means the agency specified in paragraph 2(1)(a) of the Fourth Schedule to the Act;

"existing factories" means factories which entered into operation before the commencement of these regulations;

"factory" has the same meaning as in section 2 of the Labour Act;

"industrial process" means any process operated at a factory which may entail a pollutant being emitted into the atmosphere;

"smoke" includes all particulate matter in smoke.

3. (1) The national environmental standards for the emission of pollutants in the atmosphere shall be those set out in the First Schedule.

(2) Every factory shall comply with the emission standards set out in the First Schedule.

(3) Existing factories shall comply with the emission standards set out in the First Schedule as from 1 February 1999.

4. (1) The enforcing agency may require that a chimney serving an industrial process be fitted with an aperture for the insertion of a probe to measure the composition, characteristics and quantities of emissions.

(2) The aperture shall be in the chimney wall and of such size and within such height as the enforcing agency may require.

(3) The enforcing agency may require that a safe means of access to the aperture be provided for the purpose of monitoring emissions from the chimney.

(4) Notwithstanding the other provisions of these regulations, the enforcing agency may decide that certain parameters in the First Schedule shall not apply to any specific chimney.

5. (1) The national environmental standards for ambient air shall be those set out in the Second Schedule.

(2) In exercising its powers under these regulations, the enforcing agency may take account of the national environmental standards set out in the Second Schedule.

6. (1) The enforcing agency may use measuring instruments for the purpose of assessing the quality of air.

(2) Measuring instruments shall, for the purpose of these regulations include—

(a) any apparatus for separating any air impurity from the gas or liquid medium in which it is carried;

(b) any device to indicate or record air pollution or give warning of excessive air pollution; and

(c) any other device used for the purposes of preventing or limiting air pollution.

Made by the Minister on 24th August, 1998.

FIRST SCHEDULE

(regulation 3)

Emission Standards

The following standards are maximum limits for the corresponding pollutant

	Pollutant	*Applicable to*	*Standard*
(i)	Smoke	All stationary fuel burning source	Ringlemann No. 2 or equivalent opacity (not to exceed more than 5 minutes in any period of one hour)
(ii)	Solid particles	*(a)* Any trade, industry, process, industrial plant or fuel-burning equipment	200 mg/m^3
		(b) Any existing trade, industry process or industrial plant using bagasse as fuel	400 mg/m^3
(iii)	Sulphuric acid mist or sulphur trioxide	*(a)* Any trade, industry or process (other than combustion processes and plants for the manufacture of sulphuric acid)	120 mg/m^3 as sulphur trioxide
		(b) Any trade, industry or process in which sulphuric acid is manufactured	30 000mg/m^3 as sulphur trioxide
(iv)	Fluorine compounds	Any trade, industry or process in the operation of which fluorine, hydrofluoric acid or any inorganic fluorine compounds are emitted	100mg/m^3 as hydrofluoric acid
(v)	Hydrogen Chloride	Any trade, industry or process	200mg/m^3 as hydrogen chloride
(vi)	Chlorine	Any trade, industry or process	100mg/m^3 as chlorine

(vii)	Hydrogen sulphide	Any trade, industry or process	5 ppm as hydrogen sulphide gas
(viii)	Nitric acid or oxides of nitrogen	Any trade, industry or process in which the manufacture of nitric acid is carried out	2 000 mg/m³ as nitrogen dioxide
(ix)	Nitric acid or oxides of Nitrogen	Any trade, industry or process other than nitric-acid plant	1 000 mg/m³ as nitrogen dioxide
(x)	Carbon monoxide	Any trade, industry or process	1 000 mg/m³ as carbon monoxide

SECOND SCHEDULE

(regulation 5)

Ambient Air Quality Standards and Measurement Methods

Ambient Pollutant	*Standard (ug/m³) maximum*	*Averaging Time*	*Measurement Method**
Total suspended particles	150	24-hour	Hi-Volume Sampler
	50	Annual average	
PM 10	100	24-hours	Hi-volume Sampler
Sulph~~e~~ur Dioxide	350	1-hour	Fluorescence SO_2 Analyser Colorimetry
	200	24-hour	
	50	Annual average	
Nitrogen Dioxide	200	24-hour	Sodium Arsenite Chemiluminescence
Carbon Monoxide	25,000	1-hour	Nondispersive Infrared Photometry
	10,000	8-hour	
Lead	1.5	3-month average	Hi-volume Sampler with Atomic Absorpsion
Ozone	100	1-hour	Ozone Analyser. Chemiluminescence

* the measurement methods are those indicated or other methods acceptable to the enforcing agency

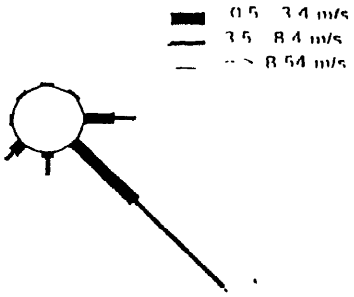
Annexure 2.6

Wind rose for the different months for the period 1996-2000 at Fort William, compiled by the Meteorological service, Government of Mauritius.

PERCENTAGE OF WIND FREQUENCIES AT FORT WILLIAM 1996 - 2000

JULY

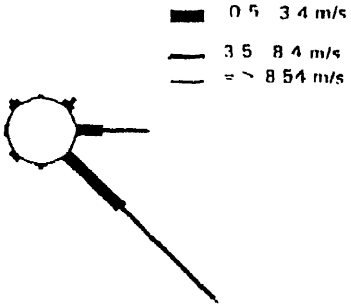
IM 2



	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	1	1	9	25	2	4	1	1
3.5 8.4	0	0	6	16	[illegible]	1	0	0
8.5	0	0	0	2	0	1	0	0

AUGUST

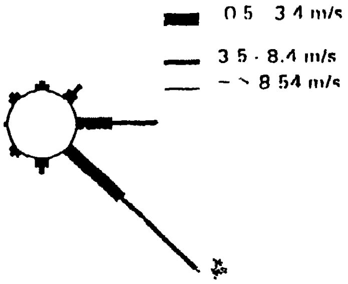
CALM = 1



	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	0	2	8	23	1	2	1	2
3.5 8.4	1	2	13	18	1	0	0	1
=> 8.5	0	0	1	2	0	0	0	0

SEPTEMBER

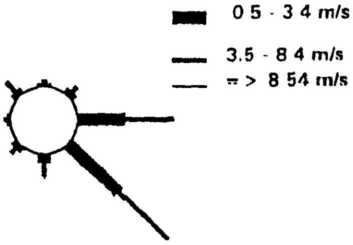
IM 2



	N	ENE	E	SE	S	SW	W	NW
3.4	2	1	10	22	3	2	0	2
8.4	1	3	13	10	2	1	1	1
8.5	0	0	1	1	0	0	0	0

OCTOBER

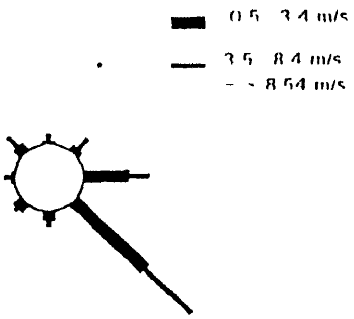
CALM = 4



	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	1	2	14	21	3	2	1	2
3.5 8.4	1	2	14	20	4	2	1	4
8.5	0	0	0	1	1	0	0	0

NOVEMBER

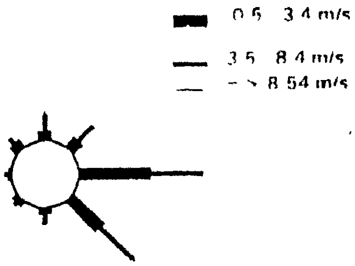
1 1



	N	ENE	E	SE	S	SW	W	NW
4	1	2	11	20	1	1	1	1
4	1	1	6	15	2	1	[illegible]	4
5	0	0	0	0	0	0	0	0

DECEMBER

CALM = 4



	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	1	4	21	11	2	2	1	1
3.5 8.4	5	6	15	13	1	1	1	2
8.5	1	0	0	1	0	0	0	0

Annexure 2.(

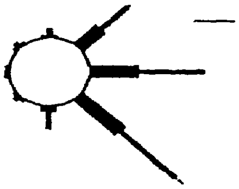
. Wind rose for the different months for the period 1996-2000 at Fort William, compiled by the Meteorological service, Government of Mauritius.

PERCENTAGE OF WIND FREQUENCIES AT FORT WILLIAM 1996 - 2000

JANUARY

CALM - 2

■ 0.5 3.4 m/s
▬ 3.5 8.4 m/s
— => 8.54 m/s



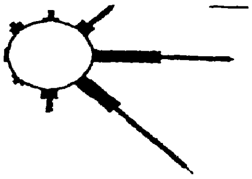
WIND IS AVERAGED
OVER 10 MINUTES

DIRECTION → SPEED ↓	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	1	8	12	15	2	1	1	1
3.5 8.4	2	9	16	19	5	1	0	1
=> 8.5	0	1	0	3	0	0	0	0

FEBRUARY

CALM = 2

■ 0.5 - 3.4 m/s
▬ 3.5 - 8.4 m/s
— => 8.54 m/s

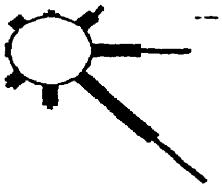


	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	1	3	16	12	3	1	1	2
3.5 8.4	2	7	17	24	4	1	0	1
=> 8.5	0	1	1	1	0	0	0	0

MARCH

CALM - 5

■ 0.5 3.4 m/s
▬ 3.5 - 8.4 m/s
— => 8.54 m/s

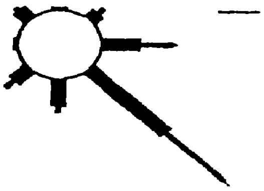


	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	[illegible]	5	12	26	6	4	1	1
3.5 8.4	1	1	12	18	1	1	0	0
=> 8.5	[illegible]	0	0	0	0	0	0	0

APRIL

CALM = 5

■ 0.5 - 3.4 m/s
▬ 3.5 - 8.4 m/s
— => 8.54 m/s

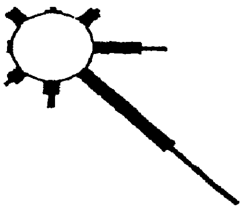


	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	1	3	9	26	8	5	1	4
3.5 8.4	0	2	8	20	2	3	0	1
=> 8.5	0	0	1	2	0	0	0	0

MAY

CALM - 7

■ 0.5 3.4 m/s
▬ 3.5 8.4 m/s
— => 8.54 m/s

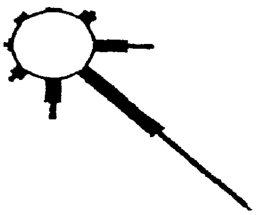


	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	[illegible]	[illegible]	12	11	4	4	1	5
3.5 8.4	[illegible]	1	6	1	4	2	0	0
=> 8.5	[illegible]	0	0	0	0	0	0	0

JUNE

CALM - 3

■ 0.5 3.4 m/s
▬ 3.5 8.4 m/s
— => 8.54 m/s



	N	ENE	E	SE	S	SW	W	NW
0.5 3.4	1	1	9	26	7	3	1	3
3.5 8.4	0	1	6	30	5	2	1	0
=> 8.5	0	0	0	2	0	0	0	0

Annexure 2 7 Detailed shift-wise ambient air quality data in and around Fort Victoria Power Station during the period March 21-25, 2002.

Date	location	Shift	RPM (µg/m^3)		SPM (µg/m^3)		SO_2 (µg/m^3)		NO_2 (µg/m^3)	
			Shift wise	24hr average	Shift wise	24hr average	Shift wise	24hr average	Shift wise	24hr average
20/03/02	Mauritius Telecom Office	Shift 1	20	19	77	55	-	19	-	50
		Shift 2	23		65		30		69	
		Shift 3	16		22		8		31	
	Mr Boodhan's house	Shift 1	40	32	127	75	-	6	-	18
		Shift 2	28		62		5		19	
		Shift 3	27		35		7		16	
	CEB House in locality	Shift 1	35	32	51	46	-	7	-	34
		Shift 2	44		64		8		37	
		Shift 3	16		22		6		31	
	Mr Sundaram's house	Shift 1	4	13	14	25	-	8	-	39
		Shift 2	17		31		10		53	
		Shift 3	18		29		6		25	
	House opposite to the CEB main gate	Shift 1	18	17	37	31	-	6	-	40
		Shift 2	21		36		5		43	
		Shift 3	12		21		6		36	
	CEB Store room	Shift 1	22	18	67	43	-	8	-	45
		Shift 2	16		38		9		47	
		Shift 3	16		24		6		42	
21/03/02	Mauritius Telecom Office	Shift 1	22	16	42	40	7	10	12	29
		Shift 2	17		46		13		23	
		Shift 3	8		32		9		51	
	Mr Boodhan's house	Shift 1	33	24	80	51	10	12	54	42
		Shift 2	25		54		15		40	
		Shift 3	12		18		10		32	
	CEB House in locality	Shift 1	18	13	31	31	7	8	11	16
		Shift 2	14		43		8		27	
		Shift 3	8		20		7		9	
	Mr Sundaram's house	Shift 1	21	14	29	23	7	10	33	45
		Shift 2	16		27		17		69	
		Shift 3	6		13		7		33	
	House opposite to the CEB main gate	Shift 1	16	10	21	18	7	7	18	25
		Shift 2	9		26		6		23	
		Shift 3	5		6		8		33	
	CEB Store room	Shift 1	21	15	39	31	4	6	24	19
		Shift 2	13		35		7		22	
		Shift 3	11		18		7		10	
22/03/02	Mauritius Telecom Office	Shift 1	16	15	21	20	7	5	46	27
		Shift 2	9		15		6		19	
		Shift 3	21		25		3		17	
	Mr Boodhan's house	Shift 1	17	20	26	38	7	6	36	32
		Shift 2	23		51		7		26	
		Shift 3	21		36		4		34	
	CEB House in locality	Shift 1	14	13	25	22	7	7	37	45
		Shift 2	12		23		10		71	
		Shift 3	12		17		4		26	
	Mr Sundaram's house	Shift 1	12	10	45	27	6	7	34	30
		Shift 2	6		15		9		36	
		Shift 3	10		20		7		22	
	House opposite to the CEB main gate	Shift 1	9	10	25	21	6	7	36	30
		Shift 2	8		12		9		32	
		Shift 3	12		26		6		22	
	CEB Store room	Shift 1	10	10	37	32	11	10	36	33
		Shift 2	-		29		10		37	
		Shift 3	-		31		7		25	

Date	location	Shift	RPM ($\mu g/m^3$)		SPM ($\mu g/m^3$)		SO_2 ($\mu g/m^3$)		NO_2 ($\mu g/m^3$)	
			Shift wise	24hr average	Shift wise	24hr average	Shift wise	24hr average	Shift wise	24hr average
23/03/02	Mauritius Telecom Office	Shift 1	21	20	31	31	8	6	62	36
		Shift 2	14		28		5		30	
		Shift 3	26		32		3		16	
	Mr Boodhan's house	Shift 1	30	26	48	44	10	10	56	42
		Shift 2	16		23		7		32	
		Shift 3	33		59		11		37	
	CEB House in locality	Shift 1	13	14	34	23	14	11	46	33
		Shift 2	10		14		11		32	
		Shift 3	18		22		7		20	
	Mr Sundaram's house	Shift 1	4	11	22	20	13	10	61	43
		Shift 2	12		18		12		49	
		Shift 3	16		21		4		19	
	House opposite to the CEB main gate	Shift 1	18	17	30	26	17	11	59	36
		Shift 2	18		28		10		35	
		Shift 3	16		18		6		15	
	CEB Store room	Shift 1	-	-	28	27	18	14	74	47
		Shift 2	-		26		15		50	
		Shift 3	-		25		9		16	
24/03/02	Mauritius Telecom Office	Shift 1	25	18	48	30	11	9	68	32
		Shift 2	17		28		6		16	
		Shift 3	11		15		8		12	
	Mr Boodhan's house	Shift 1	27	19	39	29	8	7	38	35
		Shift 2	20		29		7		38	
		Shift 3	9		18		6		28	
	CEB House in locality	Shift 1	16	11	33	21	11	8	48	37
		Shift 2	9		19		6		31	
		Shift 3	7		10		7		33	
	Mr Sundaram's house	Shift 1	26	16	30	20	11	8	46	37
		Shift 2	15		20		8		41	
		Shift 3	8		11		5		24	
	House opposite to the CEB main gate	Shift 1	20	16	35	25	9	7	56	42
		Shift 2	16		22		7		33	
		Shift 3	14		19		5		37	
	CEB Store room	Shift 1	-	-	32	28	12	9	55	46
		Shift 2	-		28		10		48	
		Shift 3	-		24		7		34	
25/03/02	Mauritius Telecom Office	Shift 1	20	14	48	29	5	5	36	28
		Shift 2	16		30		5		31	
		Shift 3	6		10		4		18	
	Mr Boodhan's house	Shift 1	28	23	80	51	10	10	36	37
		Shift 2	27		42		13		54	
		Shift 3	16		32		6		22	
	CEB House in locality	Shift 1	18	13	41	31	14	8	47	29
		Shift 2	12		42		6		18	
		Shift 3	8		11		4		22	
	Mr Sundaram's house	Shift 1	24	24	28	28	11	9	41	34
		Shift 2	35		39		7		34	
		Shift 3	14		17		8		27	
	House opposite to the CEB main gate	Shift 1	14	13	43	34	12	7	60	38
		Shift 2	17		47		5		32	
		Shift 3	8		12		4		21	
	CEB Store room	Shift 1	-	38	47	50	22	15	71	51
		Shift 2	48		80		9		35	
		Shift 3	27		21		13		47	

Annexure 2.8

Environmental standards for Noise, Govt. of Mauritius

Government Notice No. 17 of 1997

THE ENVIRONMENT PROTECTION ACT 1991

Regulations made by the Minister under sections 36 and 74 of the Environment Protection Act 1991

1. **These regulations** may be cited as the Environment Protection (**Environmental Standards for Noise**) Regulations 1997.

2. In these regulations —

"dB(A) L_{eq}" **means the equivalent** A-weighted sound pressure level **measured in decibel;**

"factory" has the same meaning as in section 71 of the Occupational **Safety, Health and Welfare** Act 1988;

"industrial noise" means noise generated by a factory;

"neighbourhood noise" means any noise other than -

(*a*) industrial noise; or

(*b*) noise made by an aircraft, an animal or traffic.

3. The environmental noise standards shall be the standards specified in the Schedule.

4. **Regulation 3 shall not,** for a period of 2 years as from the **commencement of these regulations,** apply to industrial noise if the activity **generating such noise** has already started at the commencement of these **regulations.**

5. (1) **Noise measurements shall,** as far as practicable, be effected one **metre from the nearest opening** of any residential building facing the noise source and **at 1.5 metres above** the ground or floor level.

(2) **The measurement** methods and equipment used shall be those **approved by the enforcing agency.**

6. **These regulations shall come** into operation on 1 March, 1997.

Made by the Minister on 13 February, 1997.

SCHEDULE

(regulation 3)

NOISE EXPOSURE LIMITS

Industrial Noise

07.00 — 21.00 hrs ... 60*dB(A) L_{eq}

21.00 — 07.00 hrs ... 55*dB(A) L_{eq}

Neighbourhood Noise

07.00 — 18.00 hrs ... 60 dB(A) L_{eq}

18.00 — 21.00 hrs ... 55 dB(A) L_{eq}

21.00 — 07.00 hrs .. 50 dB(A) L_{eq}

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* **Apply a tonal character adjustment of +5 dB(A) to the measured value where the noise has a definite continuous note such as a whine or hiss.**

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

MAN INSIDE (N1)

Date of monitoring (20/03/2002)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
100.3	100.9	101.1	106.2	105.8	105.6	106.1	105.8	106	106.6	106.1	101.2	101	101	76.4
100.6	101	101	105.5	104.5	104.7	105.3	104.4	104.1	105.9	105.7	101.1	101.1	100.9	76.8
100.8	101.1	101.2	107.2	106.2	106.4	107.5	106	106.6	104.5	104.5	101.2	101.2	101	77
101.1	105.3	100.9	104.9	104.2	107.9	106.9	105.5	105.3	107.6	106.2	101.1	101.1	101	78
101	106.4	105.1	104.8	106.4	108.3	104.8	104.6	105.5	104.6	107.2	101	101.2	101.1	80.7
100.6	105.7	103.9	104.5	107.2	109.6	104.3	107.5	104.3	106.3	107.9	101.2	101	101.2	77.5
100.8	107.5	104.5	105.8	106.9	104.2	105.6	105.9	107.1	107.3	104.3	100.1	101.1	101.1	77
100.4	106.3	106.3	106.6	107.4	107.6	106.4	106.2	107.5	106.2	107.8		101	101.2	76.1
100.3	105.2	107.1	107.8	104.9	105.9	105	104.9	104.1	104.2	104.1		100.9	101.1	80.8
100.9	104.8	105.9	105.4	105.2	106	107.4	107.6	107.2	107			101	101.2	77
100.5	107.6	106.1	106	104.4	104.5	104.1	104.2	105	104.4			100.9	101.1	76.1
100.6	106.2	104.8	105	108.5	105.1	106.9	105.2	106.5	104				101	80.8
100.7													101.2	77
101													101.1	76.8
100.9													101	80.2
100.7													101.2	77.4
100.6													100.8	79.2
100.5													101	
101													100.9	
100.8													101	
101													100.9	
100.9													101	
100.7													100.9	
100.8													100.8	
100.4														
100.9														
101.1														
100.8														
100.7														
100.5														
100.8														
100.6														
101.1														
100.9														
100.9														
101														

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

MAN OUTSIDE (N2)

Date of monitoring (20/03/2002)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
87.7	80.7	79.2	79.9	78.3	79	77.9	81	79.3	80.4	84.1	82.3	80.3	82.2	57.9
78.1	77	78.3	81.2	78.9	80.5	79.5	79.7	78.5	79.3	80.2	80.1	81.3	84.9	58.4
79.5	81	80.5	80.7	79.8	78	81	81.5	80.5	81.9	79.4	80	80.1	81.5	58.1
77.4	78.5	79.9	79.5	77.8	81.5	78.9	78.9	80.8	82.5	83.5	79.8	79.2	81	58
76.4	81.4	81.2	80.2	79.2	79.5	80.3	78.1	79.7	79.9	81.4	79.6	81.3	81.3	59
80.5	83.5	82	79.3	80.1	81.7	80.6	79.9	81.2	78.9	81.9	79.4	81.5	85.1	63
75.9	79.9	81.9	81.4	80.4	82.6	81.6	80.6	82.1	78.2	79.3	79.2	81.6	80.8	61.9
81.3	80.4	82.2	78.7	81.4	78.2	82.5	82.1	82.9	80.6	87.4	82.2	80.9	80.9	59
76.9	80.9	82.5	79.6	80.6	82.3	79.9	81.9	81.7	82	79.1	79.9	81.5	85.1	60.6
76.2	82.4	80.2	81.6	78.5	80.2	83.3	77.9	79.9	78.1	79.6	80.1	82.2	83.8	62.5
84.7	77.7	79.5	80.9	77.7	78.1	78.6	79.2	78.7	81.2	78.7	80.6	82.8	81.7	58.5
80	81.6	80.1	79.2	81.5	77.9	78.4	78.5	80	77.5	78.5	79.8	79.1	85	64.6
78	81.5	79.1	79.1	81.6			80.1	81.5	77.7		80.9		85.6	60.2
78.6		78.8						78.9					81.1	59.5
77.3		79.6						81.8					80.8	79.6
79.1													85	72.7
													81	74.3
													81.1	71.1
														62.1
														59

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

MIRRLEES INSIDE (N3)
Date of monitoring (22/03/02)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
56.2	101.1	101.2	101.1	100.4	99.4	98.4	98.2	71.9	72.8	99.1	99.8	101.2	101.4	72.5
55.9	101	101.1	101	100.3	99.1	98.2	98.6	71.5	72.6	98.9	99.7	101.1	101.5	72.3
56	101.1	101.2	101	100.2	98.8	98.8	98.4	71.6	72.7	98.8	98	101.2	101.3	72.4
55.5	101	101.1	101.1	100.4	99.3	99.1	98.9	71.5	72.9	99	98.5	101.2	101	72
55.4	101	101.1	101	100.3	99.2	99.3	99	71.3	72.7	98.9	98.9	101.2	101.1	72.1
56.1	101.1	101.2	101	100.6	98.2	98.7	98.8	71.1	72.3	98.8	99.1	101.1	101.2	72.3
56.4	101	101.1	101	100.4	98.5	98.5	98.5	71.2	72.5	99	99.3	101.2	101.2	72.1
56.6	101.1	101.1	101.1	100.5	98.4	99	98.1	71.5	72.4	98.9	99.4	101.1	101.2	72.3
56.9	100.9	101.1	101	100.1	99.7	98.9	98.5	71.4	72.3	98.8	99.6	101	101.3	72
58.9	101.1	101.1	101	100.5	99	98.1	98.8	71.5	72.5	99.1	99.7	101.1	101.5	72.1
57.7	101	101.1	101	100.7	98.1	98	99	71.6	72.4	98.9	99		101.4	72.5
58.5	100.9	101.1		100.3	98.4	98.3	98.5	71.3	72.6	99	99.4		101.3	72.4
58.6				100.2	99.1	99.2	98.7	71.4	72.7					
57.9					98.7	98.1	98.9	71.5						
					98.9	98.5	98.6	71.6						

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

MIRRLEES OUTSIDE (N4)

Date of monitoring (22/03/2002)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
57	76.6	77.7	76.6	73	70.1	70.8	70.3	54.2	54.2	52.9	68.1	70.2	79.9	66.3
56.7	77	77.6	77.1	73.3	70.4	70.4	70.7	51.4	51.4	52.6	68.2	69.5	79.3	66.2
58.9	76.2	77.1	76.9	73.1	69.9	70.2	71.1	54.5	54.5	52.2	68.2	69.7	79.7	66
61.5	76	77.8	77.2	72.9	70.2	71	70.9	51.9	51.9	52.7	68	69.9	79.8	66.7
57.2	77.5	77.9	76.8	72.6	70	70.9	70.6	53.7	53.7	52.5	67.7	70	80.1	66
57.4	77.9	77.2	76	72.7	69.8	70.5	70.4	54.4	54.4	52.9	67.6	69.9	80	66.3
56.9	78.1	78	74.6	72.9	70.6	70.3	70.3	52.5	52.5	53.1	67.8	70.3	79.9	66.1
56.8	78.2	77.8	74.5	73	70.5	71.1	70.1	52.8	52.8	53.8	67.9	69.5	80	66.4
60.4	77.8	77.9	75	72.9	70.6	70.4	70.2	52.9	52.9	54.4	68	70.2	79.3	66.1
60.1	78	78.2	74.9	73.1	70.3	70.7	70.8	52.3	52.3	54.6	68.1	69.9	80	66.5
57.5	77.5	77.5	74.3	73.2	70.4	70.1	70.9	52.1	52.1	53.3		70.2	79.9	66
60.7	77.7	77.1	74.5	73.3	70.7	71.1	70.1	53.6	53.6	53		69.9	80	
59	77.8	77.4	74.6		70.2	70.5	69.9	51.8	51.8	54.1		70.2	80.1	
58.3	77.5	77.9	74		70.5	70.8	70			52.8				
59.4	77.4	77.3	75		70.2	70.3	69.8							
57.7		77				70.7								
		77.4				70.5								

Annexure 2.9 -

Ambient Noise Level Data (11 Stations)

IN FRONT OF ELECTRICAL SUB STATION (N5)

Date of monitoring (20/03/2002)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
64.5	66	66.6	68.2	67.9	67.7	68.3	67.8	68.1	66.5	70.1	67.8	68.2	64.2	47.3
63.8	65.4	67	69	66.2	66.6	66.9	68.4	66.9	67.1	69.8	69.1	68.6	65.5	47.2
70.1	66.7	67.6	68.1	67	66.1	67.3	67.4	67.2	69	69.9	69.2	68.7	67.1	49
62.7	67.6	68.1	67	67.9	65.8	65.9	66.7	66.6	68.3	69.8	69.4	68.9	68.2	46.9
65.5	68.5	67.2	68.3	68.4	67.1	66.1	69.6	68.3	67.9	70.4	69.9	67.6	69.6	49.4
63.4	67.1	65.9	66.8	66.6	67.9	67.4	68.7	67.5	66.8	70.3	68.1	67.5	70.2	48.1
63.6	69.4	66.2	67.2	68.8	68.5	68.9	67	66	69.6	70	69	69.1	70.4	48.5
64.9	66.9	65.9	66.6	69.1	69.2	65.7	69.1	69	68.5	69.9	69.3	67.3	61.4	47.7
64	65.9	68.9	67.4	67.4	69.4	67	68.8	68.4	67.5	70	68.4	67.2	61.2	49.3
65.7	67.4	65.8	67.1	69.6	70.8	66.6	66.4	67.9	67.5	70.1	70.2	67.1	70.4	47.6
66.1	68.1	66	68.1	66.1	65.9	65.5	70.4	69.5	66.2	70.3	68.5	67.3	61.6	50.4
67.7	66.3	65.7	66.4	66.9	67.4	67.5	66.5	67.3	66.6	70.4	69.1	68	61	47.8
66.8	67.5	67.4	67.9	68		66	70.5	66.3	68			66.9	60.8	49
69.5	68.6		66.3			65.8	66.4	68.6	67.2			67.9	60.5	48.8
66			68.9			67.7	68.2	69.2	69.7			68	60.4	47.7
74.2			66.9					69.9	67.7			68.3	60.3	48.2
68.2												70.5	60	47.6
66.9												69.4	60.1	48.8
65.6												69.8	69.1	51.3
67.3												69.9		51.7
63.5														47.9
64.1														
66.4														
66.6														
65.6														

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

NEAR LAB BUILDING(N6)

Date of monitoring (22/03/2002)

8am-9am	10am-11am	11am-12noon	12noon-13	14-15	16-17
77.9	69.9	68.3	67.4	65.1	53
73.1	69.4	68.5	66.8	65.3	52.9
73.5	70.1	68.2	67.5	65.4	52.5
73.3	69.6	68.8	66.4	65	53.3
73.2	69.8	68.4	66.8	65.2	53.8
72.9	69.5	68.3	66.6	64.9	53.6
72.8	69.3	68.1	67	64.7	52.3
73	70	68.3	66.5	64.4	52.6
73.5	69.5	68.2	66.2	64.8	53.7
73.9	69.7	68.5	67.1	64.6	53.5
72.9	69.8	68.7	66.5	64.8	53
73.3	69.5	68.6	66.1	64.9	52.5
72.5	69.4	68.6	66.4	64.3	52.7
73.7	69.6	68.8	66.5	64.2	53.4
73.5	69.5	68.4	66	64.5	52.8
74.4	69.7	68.6	66.1	64.1	52.6
73.2	69.3	68.4	65.9	64.3	53.3
73.9	69.6	68.3	66.1	64.7	53.1
74.3	69.8	68.2	66.4	64.9	53.8
73.9	69.2	68.1	65.8	64.5	53.3
73.4	69.4	68.3	66.2	63.1	53.1
73.6	69.1	68.2	65.9	62.1	53.8
73.2	69.3		66.3	61	54.2
73.8	70		66.5	60.5	53.5
	69.2		66.8	60.3	53.3
			66.1	60.4	52.9
			66.2	60.1	
				60.4	
				60.3	
				60.6	
				60.5	

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

RESIDENTIAL TOWARDS MAN STATION, CEB House (N7)

Date of monitoring (23/03/2002)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	13-14	15-16	18-19	19-20	21-22	22-23
50.2	53.9	56.6	58.2	61.1	61.3	60.8	55.5	60.7	55.4	52.4	42.9
49.6	50.5	57.5	58.1	61	61	61.2	55	60.6	53.2	53.9	44.1
48.1	54.8	57	58.5	61.3	60.9	59.8	54.8	61	54.4	52.6	44.3
51.3	54.2	56.1	57.6	61.5	61.4	59.5	54.6	60.5	54.6	53	44.1
53.5	52.5	55.7	57.7	61	61.6	60	55.2	60.3	53.9	52.4	44.5
49.4	51.2	57.2	57.9	61.6	61.9	60.5	54.9	60.9	53.7	52.8	44
47.7	56.5	57.7	58	62	61.5	59.9	55	61.1	54.3	53	43.7
48.2	57.1	55.9	58.3	62.2	61.1	60.6	54.9	60.1	54	52.7	44
47.8	52.2	55.3	58.1	61.8	61	60.3	55.4	60.4	54.1	52.8	43.8
47	55.5	55.6	57.9	61.9	60.6	60.1	55.5	60.9	54.3	53.9	44.5
48.4	51.1	55.4	57.5	61.5	60.8	60.4	54.9	61	53.9	53.7	43.6
47.6	54.5	56.7	58	61.7	60.7	60	54.7	60.8	54.1	53.8	43.1
46.9	56.3	56	57.9	61.9	60.6	61	54.6				42.7
47.7	56	55.8	58.1	61.5	60.8	59.9	55				44.1
49	52.1	55.4	57.7	61.4	61.1	59.6	55.3				
48.7	49.7	55.9	58.1	61.7	61.6	59.8	55.1				
	50.4	56.2	57.8	62.3	61.9	60.4	54.9				
		58.8	58	61.9	62.1	59.6	54.8				
		55.6	57.9	62.1	61.5	59.3	55				
		55.1	58	61.8	61.3	58.9	54.6				
		55.3	57.7	62	61.1	59	55.2				
		55.7	58.2	62.2	60.6	59.1	54.7				
		56	57.9	62.6	60.9	58.8	54.9				
		55.5	58.4	61.9	60.6	58.7	55				
		56	58.2	61.6	60.8	59					
		55.8	58.5	61.7	61	59.7					
		55.3		61.2							
		56.1		61.4							
		55.4		61.3							
		55.2		61.7							

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

RESIDENTIAL TOWARDS MIRRLEES STATION (House Opposite to the CEB Maingate) N8

Date of monitoring (21/03/2002)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
58.7	60.8	67.4	67.4	59.2	55.9	68.1	68.3	68.5	68.1	73.3	72.2	64.5	50.2
58.2	62.5	68.1	67.6	58.6	56.3	68	68.2	68.3	68	66.3	68.1	64	49.6
57.3	61.4	67.5	67.2	60.9	57	67.9	68	68.5	67.8	66.5	67.6	66.2	47.2
59.5	60.5	67.7	66.9	58	56.2	67.6	68.2	68.9	67.6	73.3	68	67.2	47.4
58	62.9	67.9	67	59.9	55.4	68.2	68.1	69.1	67.9	64.1	68.2	69.4	47.3
57.2	61.1	68	67.1	58.2	56.5	67.7	67.9	68.6	67.8	66	68.2	69	50.8
57	60.9	67.3	67.7	59.3	55.8	67.4	68.2	69	68.1	66	67.8	63.3	47.1
58.8	63.3	67.8	67.5	60.3	57.2	67.8	68	68.2	68.5	66	67.1	69	46.6
57.1	62.4	68.3	67.3	58.1	56.6	67.5	68.1	68.6	67.7	66.6	68.5	68.7	47.2
59.4	61.8	67.6	67.8	59.4	55.9		67.7	68.4	68	71	67.6	62.7	47.9
56.7	61.9	67.6	66.8	59.6	55.2		68.2	68.3	67.3	66.1	69.1	57.3	47.1
56.9	62.8	67.5	67.9	58.5	54.9		67.8	68.1	67.4	66.2	68	57	46.8
57.9	62.5	67.2		59.1			67.6	68.4	67.1	65.9	67.9	60.8	46.5
	60.5	68.1		58.8			68.2		67	67.1	69	57.5	
	61.6								66.9	66.7	69.1	54.4	
										67.7	68.1		
										71.1			
										68.6			

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

RESIDENTIAL AREA (MR. SUNDARAM'S HOUSE) N9

Date of monitoring (24/03/2002)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
49.8	44.8	46.6	47.8	43.7	50.1	50.4	50.8	46.1	42.1	47.1	49.8	58.1	57.4	44.3
49.9	47.6	46	50.2	48.3	50.5	48.9	51	49.9	41.1	46.9	68.5	58	55.3	42.9
49.7	46.2	47.4	50.2	45.7	50.8	49	58.1	45.7	43.8	47.6	63.2	59.4	59.1	42.8
50.1	44.8	44.7	48.4	44.2	42.4	49.1	50.1	50.1	45.5	48.2	71.5	60.1	63.1	42.4
53.4	47.6	45.1	44.2	46.6	42.8	50	47.8	42.3	47.6	47	72.6	62.3	65.6	43.2
55.1	47.5	43.5	49.8	48.3	43.5	50.6	46	44.7	47.4	49	71.4	64.8	69.7	43.4
58.2	47.6	48	48.9	43.6	44.6	49.5	46.4	50	45.7	46.6	70.2	69.7	64.3	43.7
58.1	46.7	47.1	43.5	50.1	50	48.7	47.3	47.7	44.4	46.8	68.5	69.1	58.2	43.2
57.3	47.2	46	49.6	49.7	49.8	47.4	49.1	47.9	46.1	47.6	58.2	59.1	56.5	43.1
57.6	47	44.7	47.9	41.4	49.7	46.5	49.8	50	46.4	48.3	48.1	60.1	57.3	42.6
57.9	45	43.8	50.1	44.8	49.6	44.6	49.1	42	45.4	47.4	64.6	68.4	56.7	42.5
54	47.5	48	50	46.9	50.6	45.1	50.1	50	42.9	44.9		68.7		42.7
54.1	46.7	47.7	44.3	50	42	45.8	50.5		47			68.9		
	46.7	48		43.7	48.9							64.3		
	47.6	45.1										64.8		

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

FOOTBALL PLAY GROUND, AT A DISTANCE OF ABOUT 1m FROM HIGHWAY (N10)

Date of monitoring (24/03/2002)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
80.5	60.5	64.5	59.9	69	76.2	55.1	76.4	60.8	59.1	57.5	62.5	57.3	60.8	53.1
63	57.2	74.1	74.3	74.3	80.4	55	61.9	55.3	60.4	58.7	63.4	56	61.4	53.3
71.5	76.9	76.8	78.7	68	60	55.4	73.5	69.4	65.1	65.5	64	62.8	65.6	55.6
68.2	70.4	83.6	72.9	85.1	73	56.3	79.7	70.1	78.8	64.3	64.8	63.9	57.3	51.9
70	73.1	76.6	77.2	70.3	75	57.2	61	78.9	78.1	61.6	65.1	57.6	58.4	48.5
57.4	78.6	81.7	77	71.4	80.3	58.1	77.8	75.7	74.3	64.2	70.5	49.2	71.5	49.8
75.3	75.2	74.8	75.6	78.7	83.2	59.8	78.6	69.1	70.7	58.5	68	54.5	72.3	49.2
74.8	77.6	75.8	77.1	81.3	55.9	59	56.7	76.6	58	55.7	68.4	68.2	76.7	48.8
65.1	80.1	56.6	79.8	60	83.3	59.8	68.5	55.6	59.1	67.4	68.6	58.8	70.8	52.1
60.8	59.4	76	80.1	84.9	55.9	59.1	79	76.1	60.1	56.6	68.1	57.7	70.5	53.8
59.4	58.9	74.7	83.3	83.2	75.4	58.8	78.2	75.8	64.5	67.2	61	63.4	59.4	54.6
62.9	77.5	77.4	56.8	81.8	80.1	57.6	61.9	79.4	67.3	65.8	68.9	52.8	57.6	56.1
61.1	80	80.9	56.7	80.9	70.9	56.5	67.3	79	69.1		70.4	56.4	58.4	
60.4		80.6		81.5			80.1		70.4			54.8	59.6	
74.6		69.1					79					54.9	60	
												55.6	65.4	
												49.8		
												56.3		
												56		

Annexure 2.9 -
Ambient Noise Level Data (11 Stations)

FOOTBALL PLAY GROUND, AT A DISTANCE OF ABOUT 50m FROM HIGHWAY

Date of monitoring (24/03/2002)

7am-8am	8am-9am	9am-10am	10am-11am	11am-12noon	12noon-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
51	52.1	50.4	48.3	59.8	52.6	68.5	49.8	44.4	50.1	58.3	70	71.3	58.1	69
48.2	54.3	56.8	50.3	59.7	50.6	67	53.4	47.3	51.2	61.3	68.2	63	59	68.6
51.4	54.8	52.8	54.4	60	59.1	65.1	54	44.1	55.5	62.2	66.9	64.7	60	64.2
47.7	53.9	49.3	59.3	60	58.4	57.6	64.7	41.2	69.1	64	69.5	62.8	59.1	65.1
57.1	56.1	51.4	56.1	59.8	49.6	58	49.7	47	69	59.8	71.6	62.3	57.2	55.6
57	56.8	60	50.1	59.9	51.4	59	52.3	47.1	48.5	57.8	72.4	63.5	58.4	63.4
49.8	52.7	54.4	47.8	60	58.2	61.2	53.2	47.5	49	55.3	62.3	67	60.1	62.5
56.5	56.5	47	48	59.8	48.1	62.4	49.9	44.1	64.3	52.4	60.4	66.2	59.8	60.8
54.9	49.5	49.3	57.7	59.8	52.6	63.6	51.4		66.8	59.1	59.3	63.6	60	63.5
56.8	49.9	50.4	58	59.8	47.9	63.8	55.7		69	60.5		64.5	57.8	58.6
46.2	48	60	59.7		49.6	69	54		67.6	59.5		63.9	58.4	67.1
55.3	50.7	51.4	48		59	68.7	60		66.5	60		67.1	59.6	55.1
57	54.8	56.4	51.7			68	59.9		64				60.1	56.1
49.4		51	55.5			68.1			64.3					
56.7														

Annexure 2.10 -
Ambient Noise Level Data 4 Stations (Scenario)

No Engine

Plant Boundary near Man			Plant Boundary near Mirrlees			CEB House			Mr.Boodan's house		
552-0702	2155-2205	2150-2200	0702-0712	2212-2222	2200-2210	0642-0650	2245-2255	2220-2230	0630-0640	2245-2255	2210-2220
47.7	52.2	55	51.9	52.1	43.6	47.8	50.8	42.9	51.2	48	59.5
49.9	52.1	54.7	44.7	52.9	42.7	48	50.1	44.1	46.3	47.3	60.5
50.1	52	54.8	44.2	44	43.7	49.9	50.4	44.3	49.4	47.8	60.1
50.4	51.5	54.6	44.5	49	44.2	48.2	51.7	44.1	46.4	48.1	60.8
50	52.9	54.8	44.8	51.8	42.3	47.6	51.9	44.5	47	47.6	59.7
49.9	52.8	53.8	45.2	52.3	43.6	50.1	51.8	43.7	46	47.4	59.2
50.5	51.1	54.7	44	51.9	43.9	51.7	51.9	44	46.6	47.9	58.6
51.1	51.3	55.1	45	44.7	42.7	49	52.1	43.8	47	48.2	60.1
51.5	51	52	47.7	44.2	42.8	47.8	50.8	44.5	47.6	48	59.9
51.7	52.4	54.8	44.7	44.5	43.4	48.5	51.8	43.6	46.4	47.7	59.1
51.9	53	53.4	44.8	44.8	44.2	48.7	51.9	43.1	45.9	47.8	56.9
52.2	52.9	54.8	44.3	45.2	44	49.2	51.1	42.7	48.2		60.7
51.9	53		45.1	44		49	51	44.1	49.1		57.5
53.1			49.1	45		46.4			47		58.2
51.8			47	47.7		46.8			47.8		58.4
51.5			49.5	44.7		46.9			47.7		
51.2			50.8	44.8		47.9			48.3		
51.7			44.5	44.3		50.6			47.4		
52.3			44.8	45.1		48.2			47.9		
53.3				49.1		48.3			47.6		
				47		47.7			47.5		
				49.5		48.4			48		
				50.8		48.6			47.8		
				44.5		49			47.1		
				44.8		54.1					

Annexure 2.10 -
Ambient Noise Level Data 4 Stations (Scenario)

1 MAN

Plant Boundary near Man		**Plant Boundary near Mirrlees**		**CEB House**		**Mr.Boodan's house**	
0841-0851	2025-2035	0830-0840	2015-2025	0800-0815	2110-2120	0817-0827	2100-2110
63	60.6	56.7	47.9	53.9	52.4	54.1	49.6
63.5	61.1	55	47.6	50.5	53.9	56.4	50.1
65.1	60.5	55.4	48	54.8	52.6	56	50.7
62.1	60.4	56.8	48.1	54.2	53	55.1	49.9
64.2	62.2	57.3	48	52.5	52.4	52.5	49.5
61.7	60.6	56.9	47.6	51.2	52.8	54.5	49.3
61.6	60.3	54.8	48	56.5	53	55.8	50.5
64.6	61.1	56	47.9	57.1	52.7	55.4	50.7
63.9	62.1	55.6	48.2	52.2	52.8	52.3	50.6
66.2	62.2	58.1	48.3	55.4	53.9	54.7	51
61.6	60.4	57.9	48.2	54.1	53.7	53.3	50.7
66.3	62.2	56.9	47.6	54.5	53.8	52.6	50.8
61.5		58.8		56.3		53.2	
70.3		55.7		56		53.6	
70.6				52.1		55.4	
66.6				49.7		54.8	
				50.4			

Annexure 2.10 -
Ambient Noise Level Data 4 Stations (Scenario)

		TWO MAN					
Plant boundary near Man		Plant boundary near Mirrlees		CEB House		Mr.Boodan's House	
0941-0950	2030-2040	0930-0940	2045-2055	0902-0910	2100-2110	0915-0925	2110-2120
65.2	65	53.1	52.2	56.6	61.8	63.9	51.3
66.5	67	53.3	53.2	57.5	61.4	63.2	50.7
66.9	67.2	54	52.8	57	62	64.5	53.2
66.3	67.9	52.9	53	56.1	62.4	63.5	49.7
65.4	67.7	52.6	52.8	55.7	62.7	64.8	49.2
66.6	65.1	52.8	52.7	57.2	62.9	63.2	49.1
65.9	67.9	53.2	53.7	57.7	63.4	63	50.4
66	66.9	54.1	54	55.9	62.8	62.8	50.6
67.8	68.8	54.3	54.2	55.3	61	59.9	49.8
65.5	68	52.7	53.1	55.6	61.2	60.2	51.5
65.1	66.7	53.4	54.1	55.4	62.7	64.3	50.9
65.5		54.8	53	56.7	62.8	61.8	52.1
65.3		53.9		56	63	60.7	51.1
66.1		53.3		55.8	62.4	62.1	53
68		53.1		55.4	63.3	60.3	52
64.9		53.8		55.9		59.8	
66.8		53		56.2		62.2	
65		53.8		58.8		60.6	
65.2		54.5		55.6		61.2	
64.7		53.2		55.1		60.5	
64.4		54.4		55.3		59.9	
65.1		53.6		55.7		59.2	
64.8		53.9		56		59.8	
65		53.3		55.5		60.3	
64.8		53.6		56		60.2	
65.2		53.5		55.8		60.1	
64.7		52.9		55.3			
65.2		53.6		56.1			
65		53.4		55.4			
64.9				55.2			

Annexure 2.10 -
Ambient Noise Level Data 4 Stations (Scenario)

		All Mirrlees, No Man					
Plant boundary near Man		Plant boundary near Mirrlees		CEB House		Mr.Boodan's House	
1420-1427	1905-1915	1410-1415	1845-1855	1356-1405	1925-1935	1645-1355	1915-1925
64.4	65.6	68.5	71.6	60.8	57.9	52.2	49.8
64.7	63.7	68.8	72.1	61.2	57	53.5	50.2
64.1	62.8	69	73.4	59.8	59.1	52.5	59.7
63.9	62.7	69.3	72.2	59.5	59.2	51	55.7
64.1	63.5	68.8	72.8	60	59.8	53.9	48.7
64	64.1	68.6	71.9	60.5	57.9	54.2	54.8
64.5	63.9	68.9	72.5	59.9	54.6	53.5	49.9
63.7	62.5	68.7	72.2	60.6	53.4	52.6	57.4
63.8	62.4	68.5	72.4	60.3	56.7	52.3	56.6
64	62.9	68.9	72.6	60.1	53.4	51.5	49.7
63.8	62.8	68.7	71.7	60.4	59.2	54.3	
64.1	61.1	69	72	60	59.8	53.1	
64.4	63.7	69.1	71.4	61	58.1	53.7	
64.5		68.9	72.2	59.9		52.8	
64.3		69.2	71.7	59.6		54.1	
64.1		69	71.5	59.8		53.2	
64		68.9		60.4		54.5	
64.3		68.7		59.6		54.4	
63.7		68.8		59.8		53.2	
63.8		69.1		60.4		54.9	
64.1		68.8		59.6		53	
63.8		68.7		59.3		52.6	
64.2		69.1		58.9		53.5	
64		69		59		52.3	
64.3				59.1			
				58.8			
				58.7			
				59			
				59.7			

Annexure 2.10 -
Ambient Noise Level Data 4 Stations (Scenario)

		All Mirrlees & 2 Man					
Plant boundary near Man		Plant boundary near Mirrlees		CEB House		Mr.Boodan's House	
1146-1155	1810-1820	1136-1145	1820-1830	1125-1134	1830-1840	1115-1124	1840-1850
68.4	68.5	68.8	73.4	61.1	66.4	54.2	52.7
68.2	68.4	69	72.8	61	69.1	53.7	51.6
68.7	68.7	69.1	72.8	61.3	66.2	54.4	51.4
69	69	68.9	72.9	61.5	68.9	53	51.2
68.1	68.9	68.9	73	61	68.5	53.4	53.2
68	69.4	68.5	73.2	61.6	65.6	53.8	54.9
67.8	69.6	68.7	73.1	62	65.7	54.6	54.4
68.6	67.9	69	73.2	62.2	65.9	53.9	58.1
67.9	70.1	69.1	72.9	61.8	67.7	54	56.9
67.7	70.3	68.8	73.1	61.9	66.9	52.7	56.4
68.1	69	68.9	73	61.5	65.6	53.8	54.8
68.4	67.9	69.2	72.8	61.4	65.5	54.2	54.4
67.8	69	68.8	73.5	61.7		54.4	
68.1	67.7	68.6	73.3	62.3		53.8	
67.9	69.2	69.3	72.8	61.9		53.6	
68.5	69.3	69.1	73.5	62.1		53.9	
67.7	69.5	68.9	73.3	61.8		53.2	
68.4	68.5	68.7	72.8	62		53.8	
68.2	69.1	69.1	73.5	62.2		53.1	
68	68.6	69	73.4	62		52.9	
68.1	69.2	68.8	73.2	61.9		53.3	
67.6		69.1		61.6		53.1	
67.4		69		61.7		52.4	
67.5		69.3		61.2		52.8	
		69.2		61.4		52.5	
				61.3			
				61.7			

Annexure 2.10 -
Ambient Noise Level Data 4 Stations (Scenario)

All Mirrlees & 1 Man

Plant boundary near Man		Plant boundary near Mirrlees		CEB House		Mr.Boodan's House	
1256-1305	1815-1825	1246-1255	1805-1815	1236-1244	1835-1845	1225-1235	1825-1835
66.1	66.5	68.8	70.2	61.3	60.7	51.5	51.6
66	68	68.7	69.5	61	60.6	51.2	52.7
66.8	68.6	68.6	69.7	60.9	61	51.9	51.4
66.5	68.4	69	69.9	61.4	60.5	52	51
66.9	67.3	68.9	70	61.6	60.3	51.8	52.6
67.1	67.9	68.8	69.9	61.9	60.9	51.4	50.7
66.3	67.5	68.6	70.3	61.5	61.1	50.8	
66.2	66.6	69.1	69.5	61.1	60.1	52.3	
66	68	68.8	70.2	61	60.4	52.9	
66.3	68.1	68.7	69.9	60.6	60.9	52	
66.6		68.4	70.2	60.8	61	51.6	
66.4		68.5		60.7	60.8	51.3	
66.7		68.8		60.6		53.4	
66.4		69		60.8		51.9	
66		68.9		61.1		51.5	
65.9		68.8		61.6		51.1	
65.8		68.6		61.9		51.5	
66.4		68.9		62.1		51.9	
66.3		68.7		61.5		52.5	
66.6		68.9		61.3		51.2	
66.8				61.1		51	
65.9				60.6		50.5	
66.1				60.9		50.7	
65.8				60.6		51.6	
65.6				60.8		50.4	
66.2				61			
66.8							
66.5							
66.3							
65.9							

Annexure 2.10 -
Ambient Noise Level Data 4 Stations (Scenario)

		One Mirrlees & 2 Man					
Plant boundary near Man		**Plant boundary near Mirrlees**		**CEB House**		**Mr.Boodan's House**	
1036-1044	1930-1940	1025-1035	1940-1950	1011-1020	1950-2000	1000-1010	2000-2010
66.3	66.1	65.4	72.5	58.7	63.4	51.5	55
65.7	68.8	65.5	72.8	58.1	63.2	51.1	54
66.5	68.5	65.8	71.9	58.5	64.4	50.6	53.8
64.7	68.8	65.9	72.4	57.6	62.7	52.7	55.1
65.1	65.5	65.6	72.6	57.7	62.6	50.5	53.3
68.2	68.7	65.8	71.8	57.9	65.1	52.8	55.9
65.3	69	65.4	72.8	58	64.1	50.7	53
65	65.5	65.3	73	58.3	66.1	49.4	52.2
66.1	69.6	65.6	71.8	58.1	63.1	49.1	52
65.7	66.5	65.5	71.9	57.9	65.6	50.2	54
65.8	66.2	65.7		57.5	64.4	50.6	50.9
66.2	70.3	66.1		58	62.3	51	53.3
65.9	69	65.9		57.9	62.4	50.9	
66	69.3	65.6		58.1	62.2	52.2	
64.9	65.2	65.2		57.7	62	51	
66.9		65.8		58.1	61.9	51.9	
66.5		66.1		57.8	61.9	51.8	
66.6		65.9		58		52	
65.8		65.5		57.9		50.7	
66.1		65.2		58		50.3	
65.9		65.8		57.7		50.5	
65.3		65.6		58.2		51.8	
65.2		65.8		57.9		50	
65		65.5		58.4		50.7	
65.8		66		58.2			
66.1		65.9		58.5			
64.9		66.5					
65		65.7					
66		65.4					
65.5							

Annexure 2.10 -
Ambient Noise Level Data 4 Stations (Scenario)

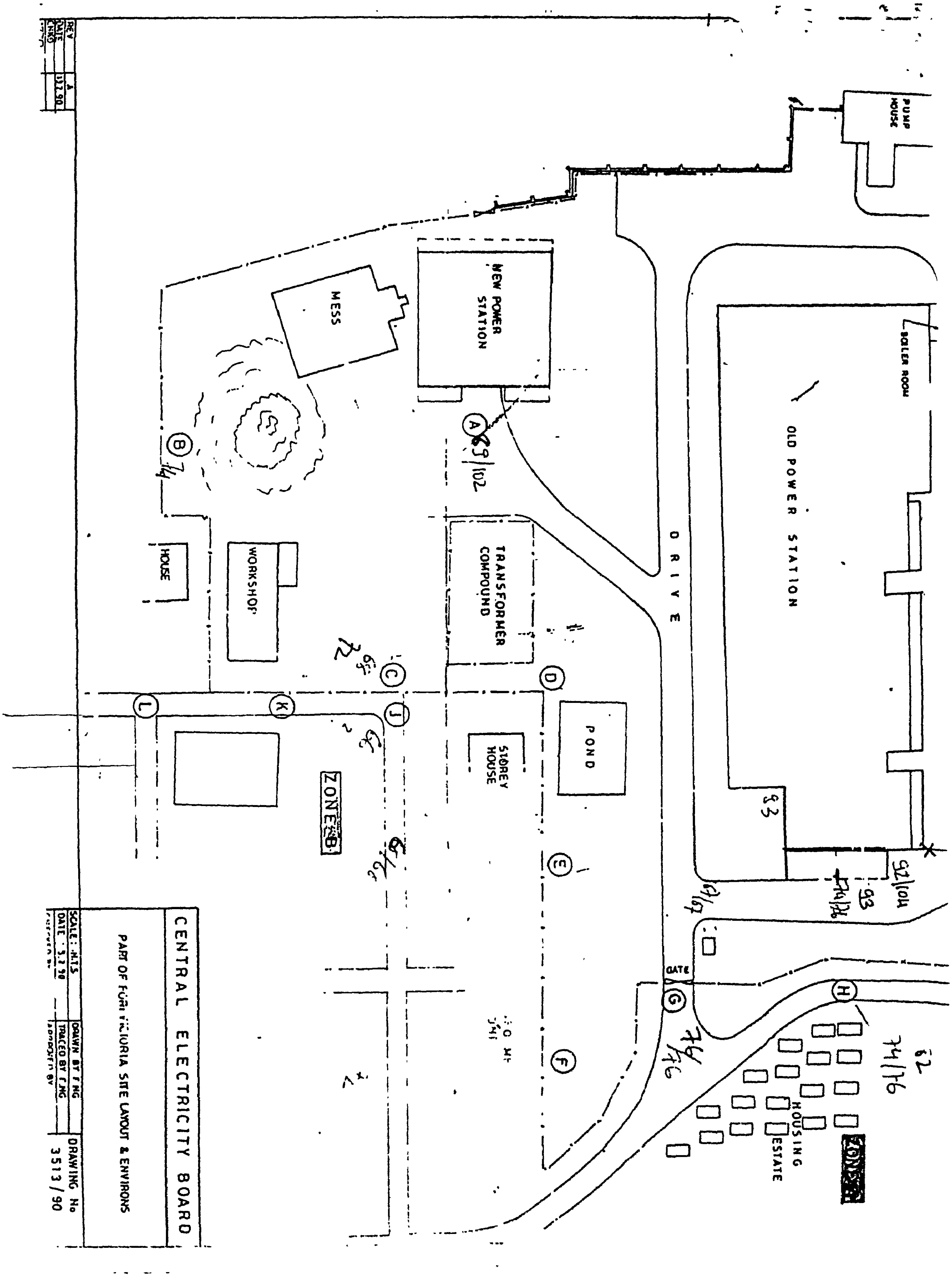
One Mirrlees & 1Man

Plant boundary near Man		Plant boundary near Mirrlees		CEB House		Mr.Boodan's House	
1522-1530	1950-2000	1510-1520	1940-1950	1545-1555	1930-1940	1535-1543	1920-1930
62.9	65.3	65.3	66.3	55.5	55.4	51.6	51.1
62	63.1	65.5	66.2	55	53.2	51.3	52.8
61.8	63	65.1	66	54.8	54.4	50	52.6
61.9	62.6	65.7	66.7	54.6	54.6	50.6	49.4
62	64.4	65.2	66	55.2	53.9	50.4	48.4
61.7	65	65.1	66.3	54.9	53.7	50.8	53.1
62.6	65.5	65.4	66.1	55	54.3	51.1	52.8
62.1	63.8	64.9	66.4	54.9	54	50.5	52.9
62	62.1	65.1	66.1	55.4	54.1	51.8	52.4
62.2	63.1	65	66.5	55.5	54.3	50.1	51.8
62.5		65.5	66	54.9	53.9	49.7	52.6
61.8		65.7		54.7	54.1	50.2	53
61.6		65.4		54.6		50.5	
63.1		65.2		55		51.6	
62.6		65.6		55.3		49.9	
63.2		65.4		55.1		50.2	
63		65.3		54.9		48.3	
62.4		65		54.8		49.2	
62.6		65.5		55		49.1	
63.1		65.1		54.6		48.8	
62.7		65.5		55.2			
63		65.2		54.7			
63.6		65.4		54.9			
62.4		65		55			
61.9							
62							
62.3							
63.1							
63.4							

Annexure 2.10 -
Ambient Noise Level Data 4 Stations (Scenario)

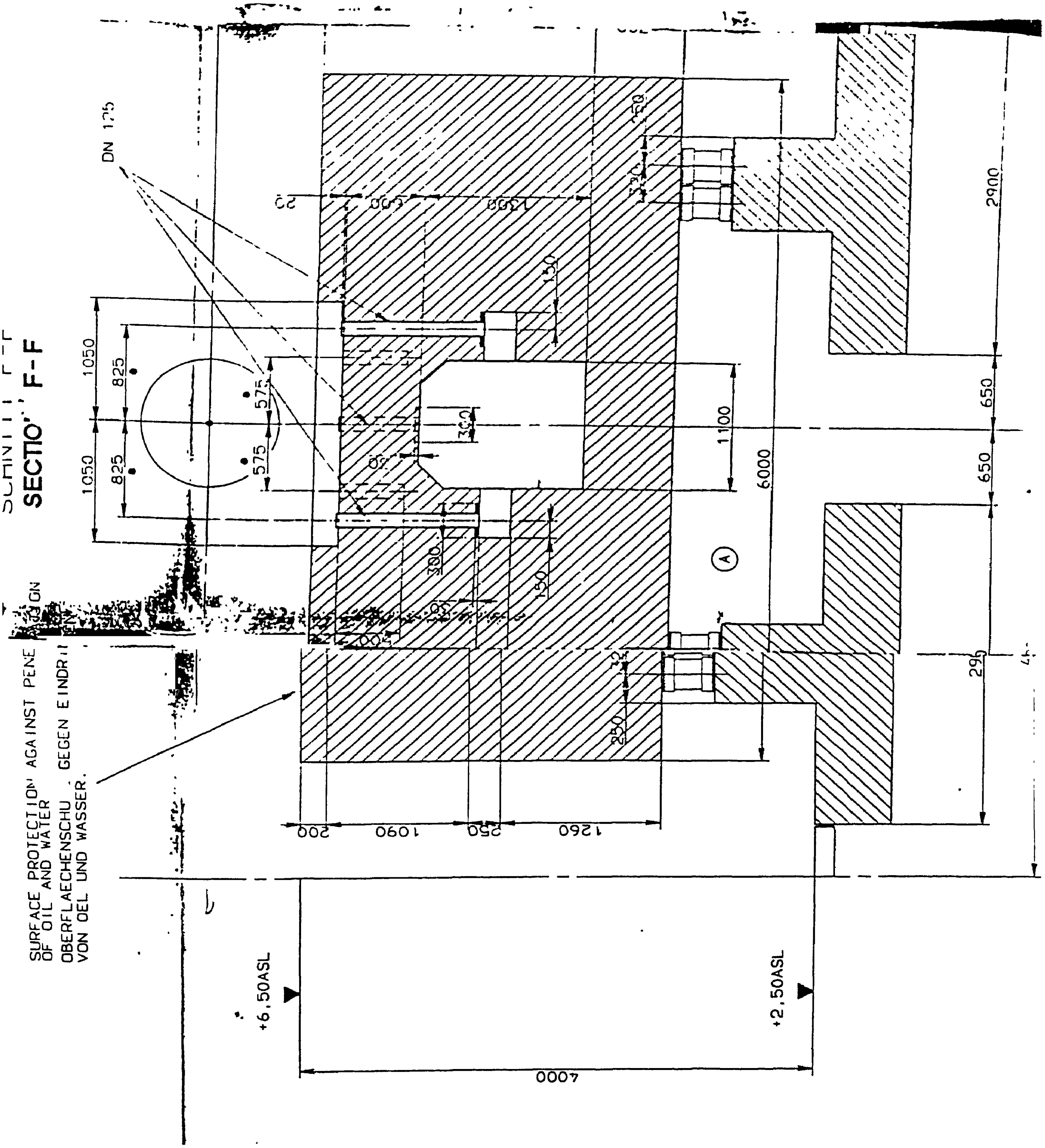
	1 Mirrlees, No Man		
Plant boundary near Man 2130-2140	Plant boundary near Mirrlees 2120-2130	CEB House 2100-2110	Mr.Boodan's House 2110-2120
56.1	65.7	52.4	51.8
56.6	67	55.1	53.1
55.7	65.7	56.1	53.8
55.6	65.7	50	52.1
55.5	65.9	48.9	51.4
55.3	66	49.4	54.1
55	66.2	52.1	50.7
56.2	65.7	51	52.7
55.4	65.5	52.1	52.1
55.7	66.1	53.1	52.4
56.3	66	49.5	50.1
54.9	65.1	56	52.4
54	66.1		

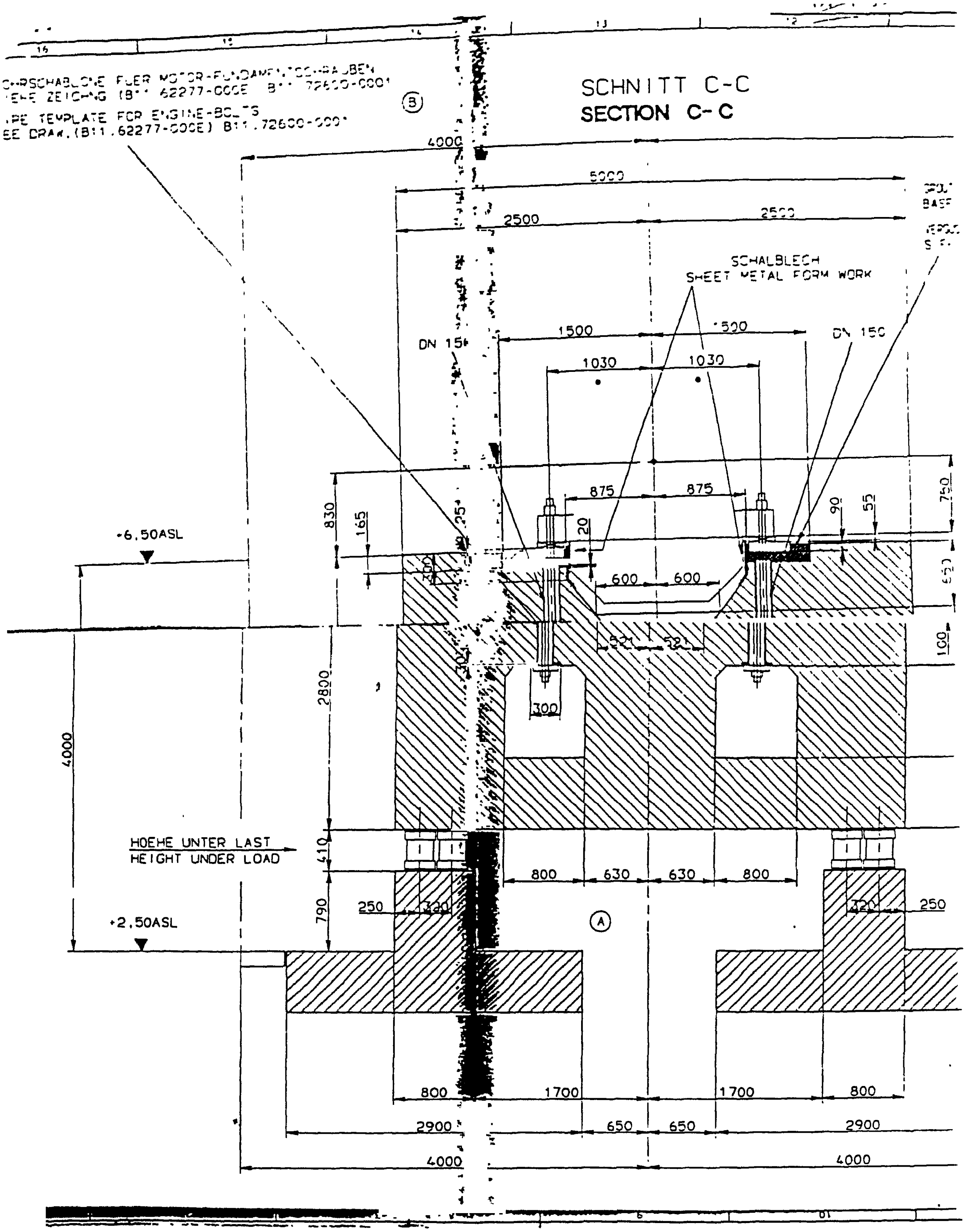
Part of Fort Victoria site layout & environs **Annexure 2.11**



Foundation drawing: MAN engines

Annexure 2.12




SCHNITT C-C
SECTION C-C
BOHRSCHABLONE FUER MOTOR-FUNDAMENTSCHRAUBEN
SIEHE ZEICHNG (B11.62277-000E) B11.72600-0001
PIPE TEMPLATE FOR ENGINE-BOLTS
SEE DRAW. (B11.62277-000E) B11.72600-0001
B
A
SCHALBLECH
SHEET METAL FORM WORK
DN 150
DN 150
+6.50ASL
+2.50ASL
HOEHE UNTER LAST
HEIGHT UNDER LOAD
1500
1500
1700
1700

Annexure 4.1

Reference list of acoustic enclosures installed
by
M/s. GERB Vibration Control Systems Pvt. Ltd.

[illegible]

GERB Vibration Control Systems

Reference List

Acoustic enclosures

Client	Project	Nos.	Dimensions [mm]			Acoustic
			Width	Length	Height	
EUT Radebeul Germany	Fan	2	800	800	1600	80 dB(A) at 1 m
VEAG Germany	Power plant Janschwalde					
	- main pump	2	2500	6200	2500	
	- gearing	2	1400	1600	1800	86 dB(A) at 1 m
Mannesmann-Seiffert	Power plant Leipzig					
	- 3 hot-water pumps	1	6000	15600	3400	80 dB(A) at 1 m
	VEAG PS Lippendorf	1	7000	15300	3000	80 dB(A) at 1 m
Turbo Howden Meißen	Eisenmann					
	- intake-air fan	2	2700	3200	2900	16 dB
	Mehldau & Steinfath					
	- 2 intake-air fans	2	1650	3000	1500	20 dB
	Municipal works Dusseldorf					
	- intake-air fan	2	3100	4300	3200	15 dB
Oertli	Municipal works Großenhain					
	- gas port	3	1600	1700	1600	65 dB(A) at 1 m
UDE, Germany	Brewery Hasseroder Heating and Power Station Wernigerrode	1	5000	6000	3200	80 dB(A) at 1 m
Lufttechnik Bayreuth	England	1	2700	3500	2300	80 dB(A) at 1 m
Turbo Howden Meißen	Mehldau & Steinfath	1	1450	1700	1600	80 dB(A) at 1 m
HV-Turbo Germany	Clarification plant Neckarsulm	3	1860	3225	1800	85 dB(A) at 1 m
	China	4	1860	3225	1800	80 dB(A) at 1 m
	China	4	2355	4170	2300	80 dB(A) at 1 m
RKR Verdichtertechnik	Turkey	3	2355	4755	2300	80 dB(A) at 1 m

Annexure 4.1

Reference list of acoustic enclosures installed
by
M/s. GERB Vibration Control Systems Pvt. Ltd.

Reference List

GERB Vibration Control Systems

Acoustic Enclosures & Blow Off Silencers in India

Client	Project	Nos.	Dimensions [mm] Length / Width / Height	Acoustic Performance
Fuji Electric Co., Japan	Bakreswar TPS / WBPDCL Turbine Enclosure	3	32000 / 13700 / 4500	84 dB(A) at 1 5 m
KSB Pumps Ltd., Pune	STCMS, Neyveli / Alstom BFP Enclosure	3	4500 / 3200 / 3000	85 dB(A) at 1m
KSB Pumps Ltd., Pune	GSPCL, Hazira / Alstom BFP Enclosure	2	6060 / 5360 / 2800	85 dB(A) at 1m
BHEL, Hardwar	Pragati Power Project DVB (120MW), New Delhi Turbine Enclosure 330 CCPP	1	14800 / 13000 / 5000 Under Execution	85 dB(A) at 1m
KSB Pumps Ltd., Pune	AES, Kelenitessa, Srilanka BFP Enclosure	2	7900 / 3200 / 3750	80 dB(A) at 1 m
Kirloskar Ebara Pumps Ltd., Pune	Akrimota TPS / GMDC BFP Enclosure	6	5700 / 2900 / 2500	82 dB(A) at 1m
Alstom / Babcock Borsig, Chennai	STCMS, Neyveli Neyvelli Zero Unit Blow-off Silencer	8	410 / 372 / 170 145 & 34 t/h	105 dB(A) at 1 m
Larsen & Toubro Mumbai	AES, Kelenitessa Sri Lanka Blow-off Silencer	8	81t/h 54 t/h	85 dB(A) at 1 m
Kirloskar Ebara Pumps Ltd . Pune	Toshiba Power Project Taiwan, BFP Enclosure	12	4150 / 2800 / 2300	82 dB(A) at 1m
BHEL Hardwar	Talcher STPP/ NTPC 500 MW Turbine Enclosure	4	14800 / 13000 / 5000 Under Execution	85 dB(A) at 1 m

Annexure 4.1

Reference list of acoustic enclosures installed
by
M/s. GERB Vibration Control Systems Pvt. Ltd.

GERB
Vibration Control Systems

Reference List

Acoustic enclosures

Client	Project	Nos.	Dimensions [mm]			Acoustic
			Width	Length	Height	
Cong AH	V E A					
	- fan room	2	10615	9620	3950	NR 60 at 1 m
	- filter room					
	- Prefilter house	1	9350	3000	4210	NR 60 at 1 m
Fuji Electric	Bakreswar, India Steam turbine	3	13700	32000	4500	84 dB(A) at 1.5 m
Fuji Electric	Kobe, Japan Steam turbine	1	16000	8000	6000	89 dB(A) at 1 m
KSB Pumps Ltd , Pune, India	STCMS, Neyveli/Alstom, India Boiler feed pump	3	3200	4500	3000	85 dB(A) at 1 m
KSB Pumps Ltd , Pune, India	GSPCL Hazira/Alstom, India Boiler feed pump	2	5360	6060	2800	85 dB(A) at 1 m
BHEL, Hardwar, India	Pragati Power Project New Delhi – India 120MW Steam turbine	1	14800	13000	5000	85 dB(A) at 1 m
KSB Pumps Ltd , Pune India	AES - Srilanka Boiler feed pump	2	7900	3200	3750	80 dB(A) at 1 m
Kirloskar Ebara Pumps Ltd Pune India	GMDC Akrimota Boiler feed pump	6	2900	5700	2500	82 dB(A) at 1 m
BHEL Hardwar, India	Talcher STPP/ NTPC– India 500 MW Steam turbine	4	14800	13000	5000	85 dB(A) at 1 m
Kirloskar Ebara Pumps Ltd , Pune India	Toshiba, Taiwan Boiler feed pump	12	2800	4150	2500	82 dB(A) at 1 m